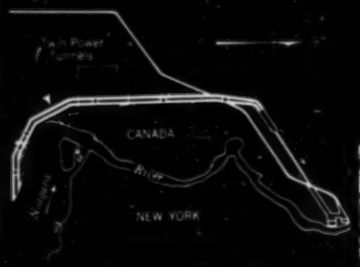
CIVIL ENGINEERING



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ATTENTION SEWER CONTRACTORS

The contractor encountered ground water and unstable soil in the construction of Fairview Road Trunk Sewer for Orange County Sanitation District No. 1, State of California. Progress due to this condition was retarded to a point where the job was almost in the red. The contractor installed a STANG Wellpoint System, and under STANG Supervision, the rate of progress was doubled.*

* Actual progress figures are on record.

● With the large sewer projects now being let thruout the country it will pay you to consult STANG on projects involving excavation in unstable, water-bearing soil so that you can take the GUESS out of your estimate.

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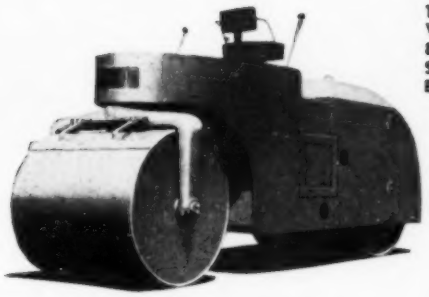

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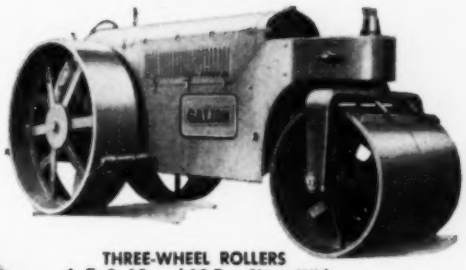

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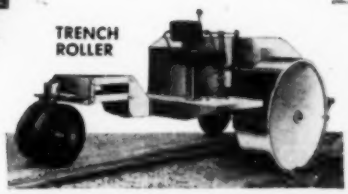
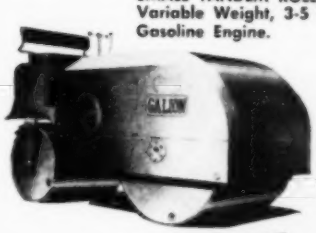
TRENCH ROLLER



SMALL TANDEM ROLLER
Variable Weight, 3-5 Ton. Gasoline Engine.



PORTABLE ROLLER
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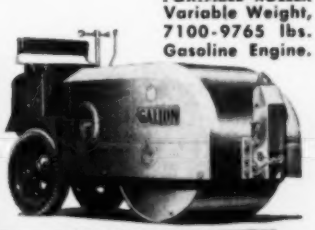

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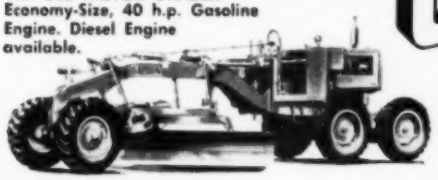

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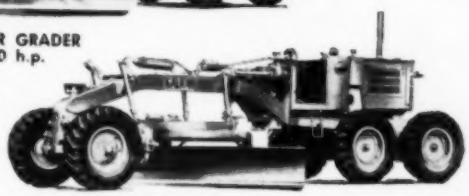

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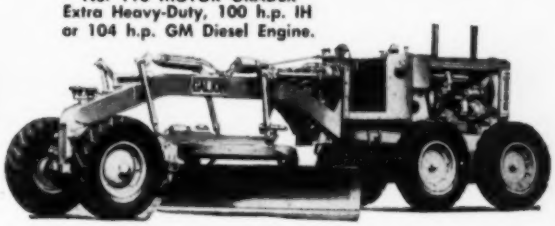

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Heat and Power Plant, Anchorage, Alaska. Footings and foundation for Eielson AFB plant, using Protex concrete, poured under adverse weather conditions.

International Air Port, San Juan, Puerto Rico. This construction on filled-in marshland, used Protex air entrained concrete for smoother surface, easier finishing and improved placeability.

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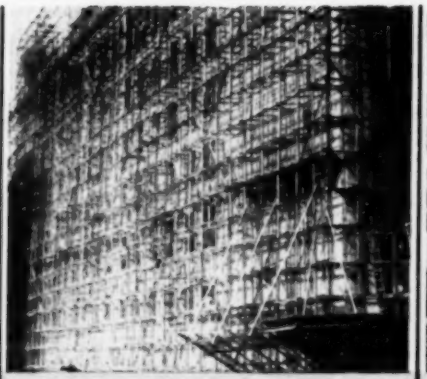
Rio Lempa Dam, El Salvador. This giant project used Protex air entraining agent for high quality concrete under normally unfavorable labor and climatic conditions.



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San Juan Housing Project, Puerto Rico. This new project, constructed on filled-in marshland, used Protex air entrainment for easier placement, reduced segregation and better surface texture.

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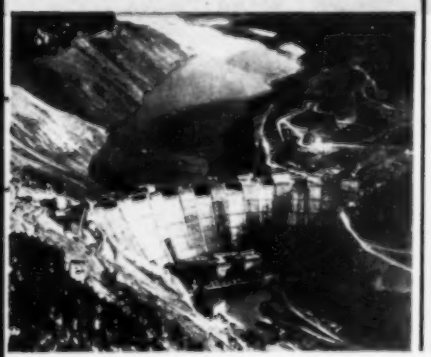

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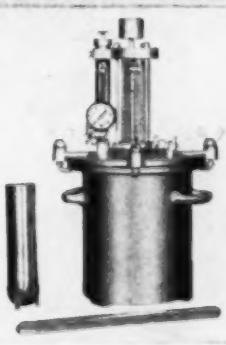

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"My TD-14As self-load six pay yards and deliver it faster than any crawlers the same size on the market."

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This kind of report comes from contractors all over the country—proof that International builds real dirt-moving machines that stand the gaff.

So see the International Industrial Distributor located near you. He has the full line of International crawlers—and as a nearby source of parts, trained servicemen and complete shop facilities, he can help keep your equipment easy on the overhead for years to come.

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POWER ON PARADE. High-production International TD-14As self-load scrapers alongside burly freight engine as they prepare building site in Minot, North Dakota.

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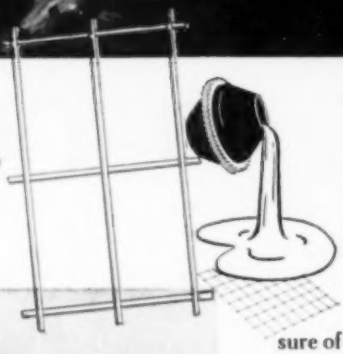

When the thaw comes next spring, you want to be ready to dig in *at once* on all important construction jobs. And you will need plenty of concrete reinforcing material on hand ready for immediate use. The best way to be sure of having enough is to anticipate your needs—stock up *now* on the sizes and types of American Welded Wire Fabric that you will use. Then, even if there is an early thaw, you will be ready with an adequate supply of the best available concrete reinforcement.

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UNITED STATES STEEL

No detail of planning was overlooked in making this new Youth Study Center one of the finest of its kind. Reinforced concrete was selected for the building's framing and floors.

The design includes flat wide beams which span the full width of the building. This framing method permitted a considerable reduction in the total height of the building as compared with conventional deep beams.

Not only did reinforced concrete permit greater flexibility of design, but it also proved *more economical*. Moreover, materials were readily available from local sources.

Reinforced concrete buildings are durable, firesafe, rugged . . . and *go up faster*. On your next job, design for reinforced concrete.

Youth Study Center, Philadelphia, Pa.

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Structural Engineers: Severud-Elstad-Krueger

Contractor: McCloskey & Co.

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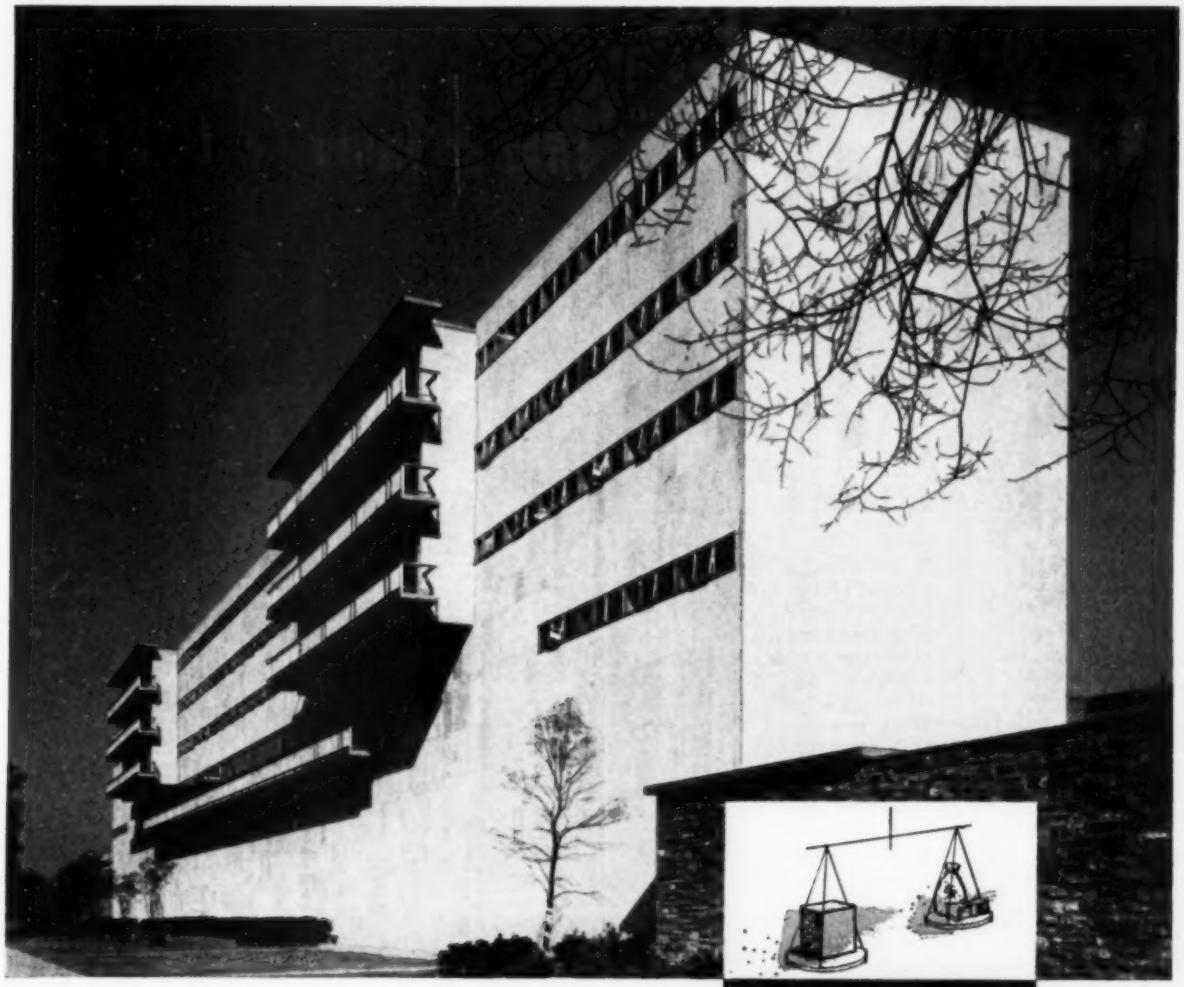

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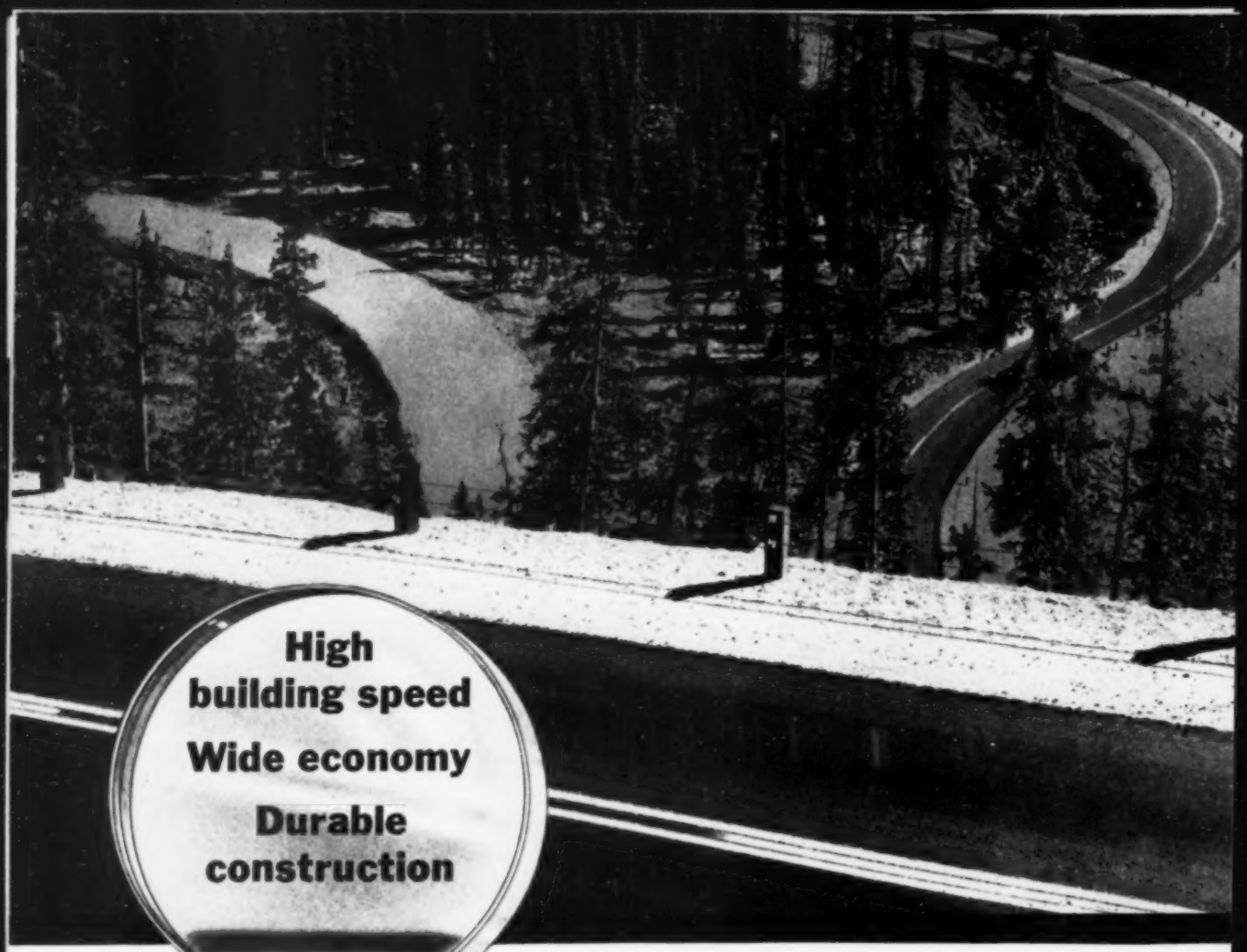

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You add further to those road building advantages by using Standard Oil asphalt. With five asphalt-producing refineries located throughout the Midwest, Standard Oil makes the haul to your job a short one. Prompt, reliable shipments eliminate work delays. Freight costs are at a minimum. Standard Oil Asphalt Representatives are situated throughout the Midwest to give you "on-the-spot" service. Phone your local Standard Oil office. Or, write: Standard Oil Co., 910 So. Michigan Ave., Chicago 80, Ill.

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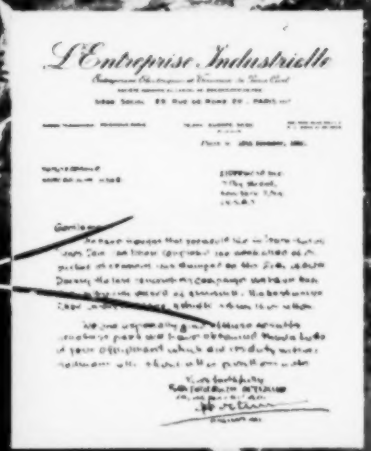
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CATERPILLAR

When construction men agree

Rarely is there such complete agreement on one make of equipment among owners, superintendents and operators as reported on these pages. Caterpillar* track-type and wheel-type Tractors, Motor Graders, Diesel Engines, Electric Sets, Scrapers and Bulldozers all share the praise of men working on the Kansas Citys Flood Control project.

CAT* NO. 12 MOTOR GRADER does quality work in tough, sticky soil on the new levee in Kansas City, Kans. Explains M. C. Green, general superintendent of Storms & Frew Construction Co.: *"We favor Cat machines because they take more abuse than other makes but still are easier to operate."*

A D13000 DRIVES TOWBOAT *JOHN THOMAS*, owned by Massman Construction Co. The boat moves and holds in place barges with 190 tons of rock to fill tow trench in the Kaw at Turner, Kans. The operator, Alan Anderson, declared: *"The D13000 has all the power I need and it's not a noisy engine. I have to live with it, so this means a lot to me."*

POWERFUL CAT D337 DIESEL powers the Joy Compressor for drilling blast holes in a new quarry to obtain rock for two Kansas City levees. Rock formations include Cement City Ledge 8' deep, Raytown Limestone 8' deep, and Argentine Limestone 30' deep. Expected production: 3000 tons daily. Says J. W. Petett, superintendent for George Bennett Construction Co.: *"This compressor gives us all the pressure we need to operate two drills without running itself to death."*

TIGHT TURNS IN SANDY SOIL were required of this D8 with No. 80 Scraper, owned by Miller Brothers Construction Co. Despite these tough conditions, the Caterpillar unit is making 45 to 50 round trips daily with heaping loads on a half-mile haul at the Kaw's mouth. Little wonder that owner W. F. Miller says: *"In the 14 years we've been operating, we have found these tractors to be our most durable and rugged machines."*

DRAGLINE DRIVEN BY CAT D13000 works 16 hours a day on the project. Owned by Massman Construction, this Manitowoc 1½ yd. dragline will dig a tow trench, fill it with rock, and dress the slope on the levee with riprap. Frank W. Pitz, superintendent, said: *"I think we have only one power shovel without a Cat Diesel in it. Sounds like we like them, doesn't it?"*

SAFETY ON THE D7 is uppermost in the mind of Johnnie Stone, operating the tractor for Bales & Kite. Says Johnnie: *"I wouldn't work on a steep bank like the ones around here with any other make of tractor."* Equipped with a No. 7S Bulldozer, the D7 is 'dozing the top of the riprap as it is dumped at the mouth of the Kaw River.

A CATERPILLAR TEAM PRODUCES for Bales & Kite at the mouth of the Kaw. The speedy DW10 with a No. 15 Scraper dumps sand where a dragline powered by a D13000 picks it up and redistributes it. It is used on the levee face to form a foundation for rock. Production: 1000 cu. yds. daily. Says co-owner M. B. Kite: *"The best all-around machines are Cat machines. They have longer life, less down time and my men like to operate them better."*

CATERPILLAR TRACTOR CO., PEORIA, ILLINOIS

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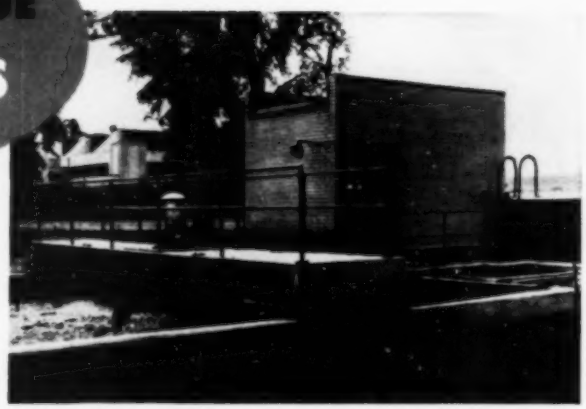
CHICAGO SEWAGE EQUIPMENT

ACTIVATED SLUDGE 'PAKAGE' PLANTS

OVER 230 IN OPERATION



Activated Sludge 'Pakage' Plant installed for the Goodyear Tire & Rubber Company Plant, Topeka, Kansas. This 18′ unit is designed to treat 125,000 gallons per day. J. G. Turnbull, Consulting Engineer.

Activated Sludge 'Pakage' Plants Consistently Specified by Sanitary Engineers

for

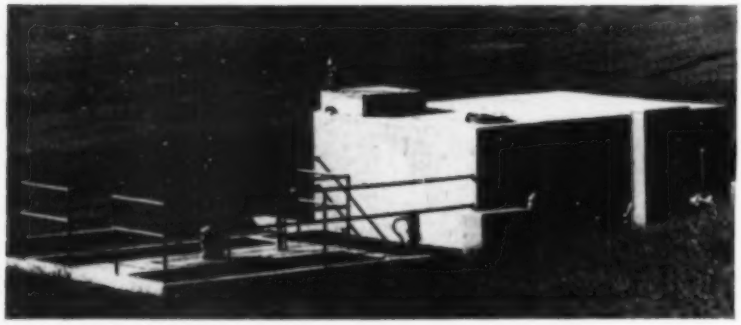
- SMALL COMMUNITIES
- INDUSTRIAL PLANTS
- AIRPORTS
- HOSPITALS, SCHOOLS and OTHER INSTITUTIONS

Activated Sludge 'Pakage' Plants have a proven 19 year record for producing sparkling clear effluent.

Many semi-automatic features simplify operation and assure trouble-free performance under all conditions. 'Pakage' Plants can be operated by men with State Board of Health minimum classification.

Aeration and clarification are accomplished in a single tank with positive sludge control that covers a wide range of sewage flows and strengths.

'Pakage' Plants handle sewage flows of from 1500 to 500,000 gallons per day in single or multiple units, and may be safely located near dwellings, as the clear effluent produced is free of flies, foul odors and unsightly appearances.



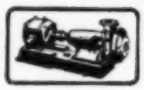
Activated Sludge 'Pakage' Plant at Contra Costa, Jr. College, Contra Costa, California. This 7′ unit is designed to treat 15,000 gallons per day. Roy E. Ramseier, Consulting Engineer.

Specify Activated Sludge 'Pakage' Plants for proven and trouble-free sewage disposal performance.

CHICAGO PUMP COMPANY

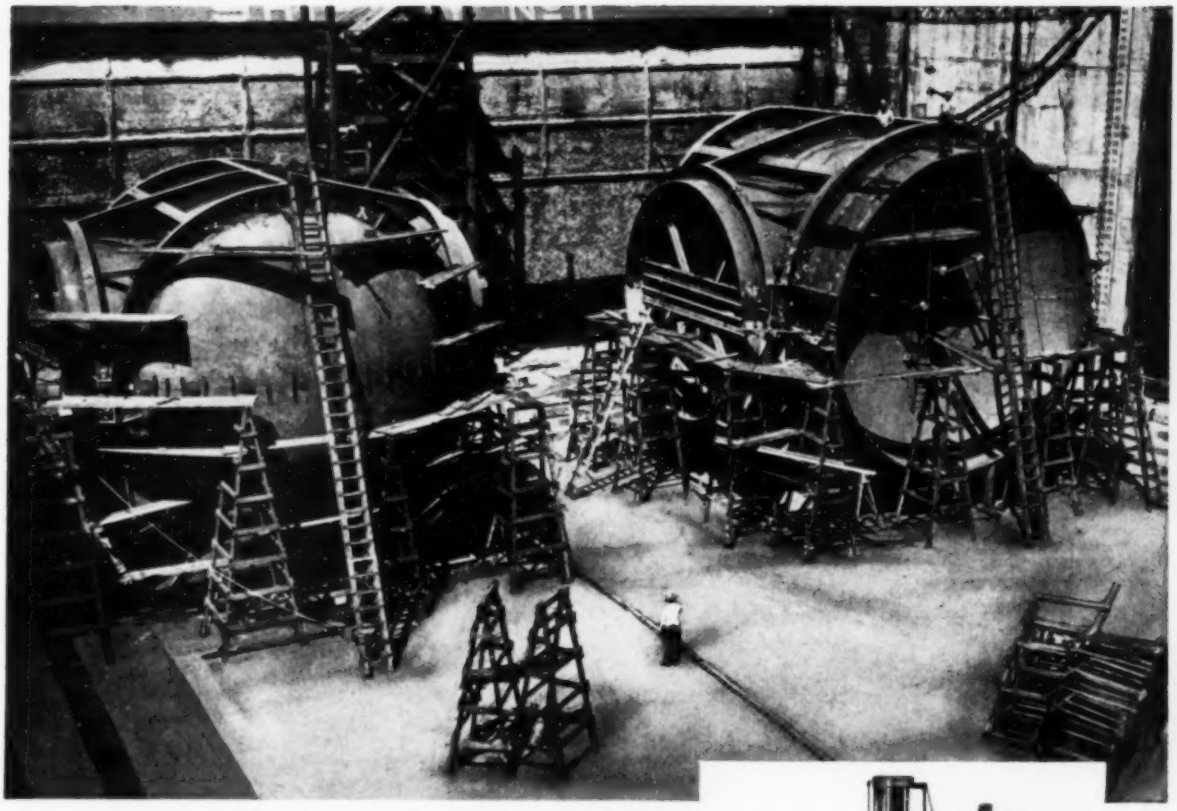
SEWAGE EQUIPMENT DIVISION

622 DIVERSEY PARKWAY — **CHICAGO 14, ILLINOIS**

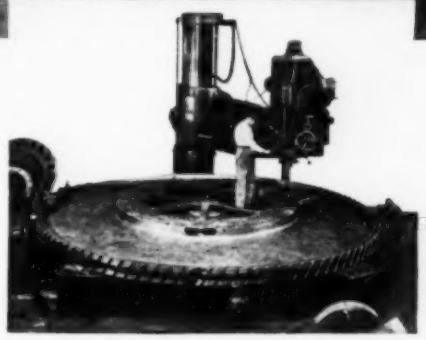


Flush Kleen, Scru-Peller, Plunger Horizontal and Vertical Non-Clogs Water Seal Pumping Units, Samplers

Swing Diffusers, Stationary Diffusers, Mechanical Aerators, Combination Aerator-Clarifiers, Comminutors.



ASSEMBLING FLOW DIVERSION VALVES of an 8-foot supersonic wind tunnel for the Ames Aeronautical Laboratory of the National Advisory Committee for Aeronautics.



DRILLING A 25-TON FORGING . . . one of 11 alloy steel discs used in one of the two axial flow compressors which Newport News is constructing for the NACA's Ames laboratory.

Man-made Hurricanes

PUSH A BUTTON . . . That's all it will take to accelerate wind up to several times the speed of sound in a new supersonic wind tunnel at the Ames laboratory of the National Advisory Committee for Aeronautics, in Moffett Field, California.

The tunnel is designed to develop new aerodynamic information. Its heart is the "windmaker" . . . two axial-flow compressors which look like a giant tube 50 feet long and 24 feet in diameter, studded with small blades.

Because of the size of this unit, it is significant that the task of building these mammoth compressors was assigned to Newport News.

Newport News has also constructed two diversion valves, similar to huge plug valves, for diverting the air flow from one channel of the tunnel to another, as desired.

Large engineering and technical staffs, operating a plant with acres of brass, iron and steel foundries, five huge machine shops and other extensive fabricating facilities, make Newport News an ideal source for large equipment . . . *standard or special in design.*

Products ranging from components of rayon spinning machines to giant 165,000 horsepower hydraulic turbines operating at Grand Coulee, reflect Newport News' high integration of skill and production facilities.

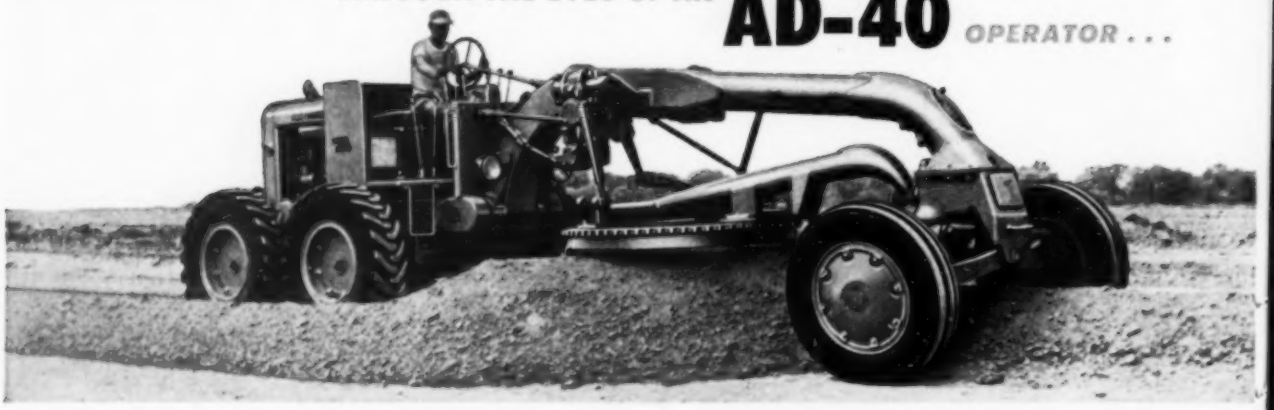
Consult us on equipment for your present or future projects. Write today for your copy of *"Facilities and Products."*

NEWPORT NEWS SHIPBUILDING AND DRY DOCK COMPANY
Newport News, Virginia

ALLIS-CHALMERS INVITES YOU TO . . .

Look at Your Grader Jobs

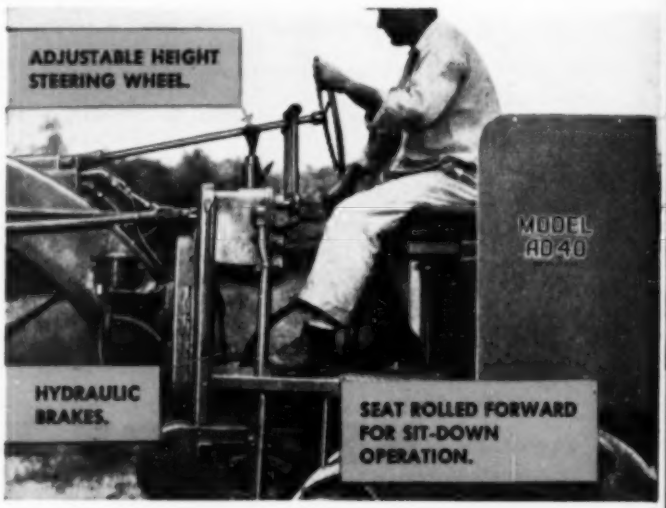
THROUGH THE EYES OF AN **AD-40** OPERATOR . . .

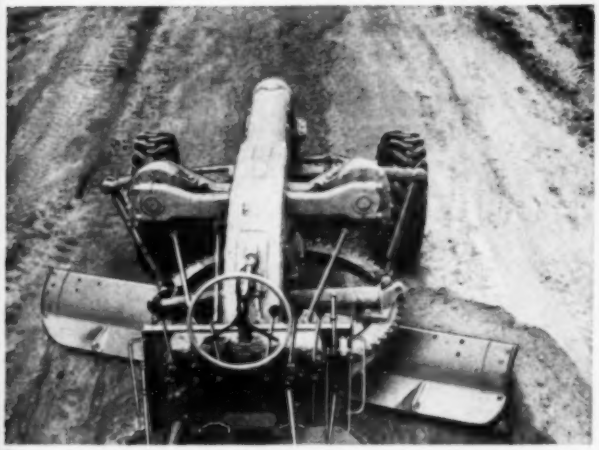


SLOPING— Look how much better you see . . . how much steadier your blade is with small control rods leading out to lift cases located directly over the circle.

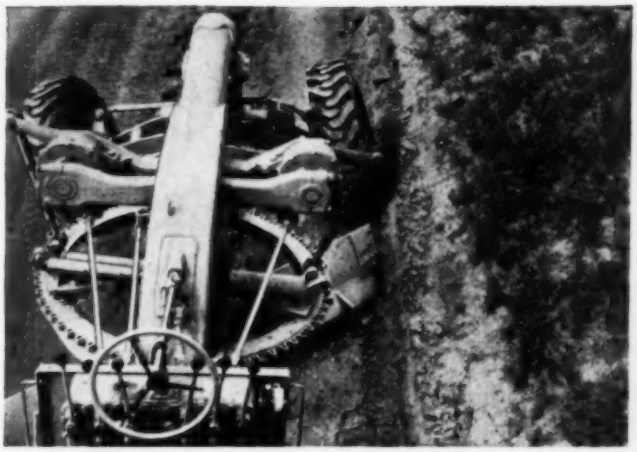
SOD STRIPPING — Look at the tapered corners on this clean, wide platform . . . how they give unequalled view of heel of ROLL-AWAY moldboard.

In addition to letting you see better, the AD-40 offers feather-touch hydraulic power steering, hydraulic brakes . . . and true comfort for any size operator, sitting or standing. *Look!*

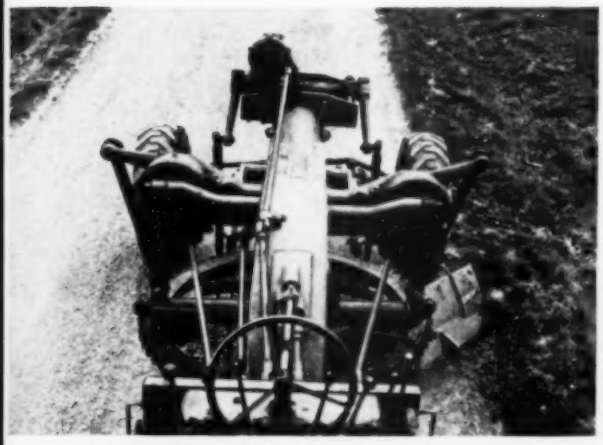




GRADING — Look at that single member frame — it really lets you see what you're doing . . . means efficient grading on *any* job.



DITCHING — Look at the low control panel. It gives you a clear view of the blade . . . helps insure a clean, smooth ditch.



SCARIFYING — Look at the AD-40, even in scarifying, and you will see it means new, better grader visibility at all times.

• 104 bhp. • Six speeds forward, three reverse • 23,000 lb. (with optional calcium chloride solution in rear tires — 24,800 lb.).

YES, the big, new AD-40 is designed for today's jobs and today's operators . . . brings new standards of performance to all users of motor graders . . . handles all grading jobs faster, better, easier. You owe it to your operators . . . and yourself to ask your nearby Allis-Chalmers dealer now for a demonstration and *see for yourself.*

ROLL-AWAY is an Allis-Chalmers trademark.

ALLIS-CHALMERS
TRACTOR DIVISION • MILWAUKEE 1, U. S. A.

Kentucky put the emphasis on flexibility when it designed this highway

Like other large cities, Louisville, Ky., has found it more and more difficult to cope with the traffic problem. To help relieve this situation, the Kentucky State Highway Department is constructing what is known as the Inner-Belt Highway, over which traffic entering Louisville from the east and south by-passes the heart of the city.

The most notable feature of this project was Kentucky's choice of a flexible type of construction from top to bottom. It consists of a 9-inch subbase of waterbound macadam, covered by a 3-inch base of hot-mix Texaco Asphaltic Concrete. To complete the highway, a Texaco Asphaltic Concrete pavement was laid in two courses, each 1½-inches thick. The result is a total thickness of 15 inches of completely flexible construction, which is capable of absorbing heaviest traffic impact year after year with a minimum of maintenance.

Texaco Asphalt Cements, Cutback Asphalts and Slow-curing Asphaltic Oils offer the road builder a wide choice of improvements for his street or highway. Whether the volume of traffic calls for a heavy-duty pavement like that on Louisville's Inner-Belt Highway, a low-cost surface for a secondary road, or an inexpensive mat to eliminate the dust and mud, there is a Texaco Asphalt product to fit the need. Helpful information for the road builder on all these types is supplied in two booklets, which our nearest office will be glad to send you.

Refined from scientifically selected crudes, Texaco Asphalt products have earned and held the confidence of America's road builders for 50 years.

Constructing one of three courses of resilient, heavy-duty Texaco Asphaltic Concrete over a waterbound macadam subbase on Louisville's new Inner-belt Highway. The contractor was the Breslin Construction Company of Louisville.

THE TEXAS COMPANY, Asphalt Sales Dept., 135 E. 52nd Street, New York City 17

Boston 16 • Chicago 4 • Denver 1 • Houston 1 • Jacksonville 2 • Minneapolis 3 • Philadelphia 2 • Richmond 19

TEXACO

TEXACO ASPHALT

Balanced Design...

ONE REASON WHY BUCYRUS ERIE BLADES CUT ROADBUILDING COSTS

WHAT BALANCED DESIGN IS ... Bucyrus-Erie bulldozers and Bullgraders are mounted on International TD-14A and TD-18A tractors so that the vital balance point of the tractor remains virtually unchanged.

WHAT IT DOES . . . It means that the tractor retains all of its original tractive effort and maneuverability. It puts maximum driving force where it belongs — at the blade. Because there is always a full length of track on the ground, you take full advantage of tractor power and get fine, accurate control over the blade. Finally, there is less wear and tear on the tractor.

HOW IT CUTS ROADBUILDING COSTS . . . Better blade control and tractor maneuverability enables operator to produce accurate grading and fine finishing in a minimum of passes — *you save time.* Having the advantage of full tractor power lets you move more dirt on every pass and get the job done faster — *you save money.* Since there is no waste of tractor power, *you save fuel costs.* And lastly, because there's no upset of balance to strain the tractor there's less wear on tractor parts — *you save maintenance costs.*

Investigate these and the many other features offered in Bucyrus-Erie blade attachments. Get the complete story from your International Industrial Tractor Distributor today. 6T53C

BUCYRUS-ERIE COMPANY, South Milwaukee, Wisconsin

TD-14A and TD-18A Bullgraders and Bulldozers Hydraulic or Cable Controlled

SEE YOUR INTERNATIONAL INDUSTRIAL TRACTOR DISTRIBUTOR

Leffel

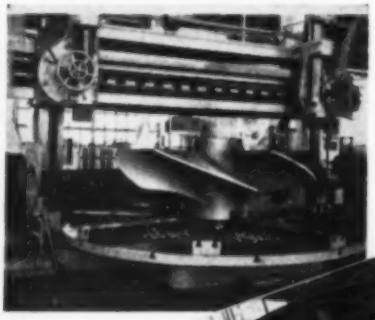
HYDRAULIC TURBINE

increases

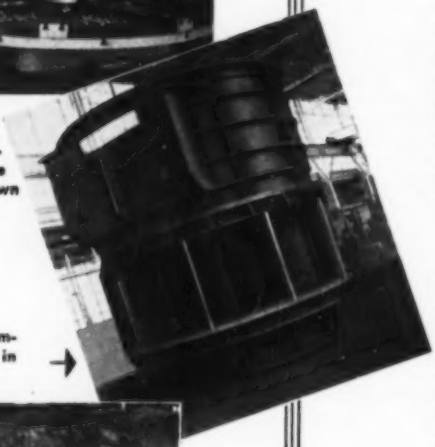
power output at

WILBUR DAM

of the Tennessee Valley Authority



Cast steel propeller-type runner for the Wilbur turbine, shown on boring mill.

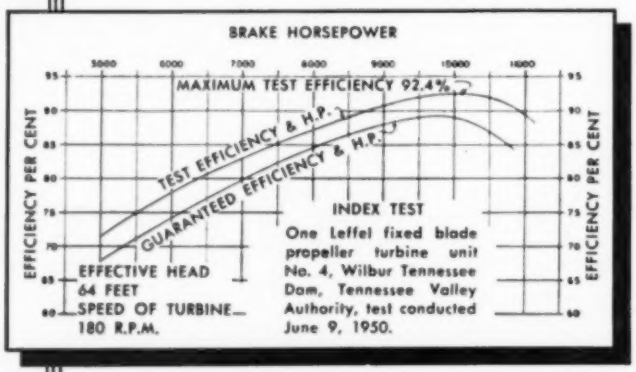


Wilbur turbine, completely assembled in the Leffel plant.

Lifting the combined runner, shaft and cover-plate during the field installation.

The Wilbur power project of the TVA is another instance where a Leffel hydraulic turbine was used for the expansion of existing power facilities. For the Wilbur installation a Leffel vertical propeller-type hydraulic turbine was used—maximum rated at 11,500 HP, under 67 feet net head, speed 180 RPM.

The Wilbur project demonstrates once again that the long-range economy and dependability of Leffel turbines make a valuable asset for any expansion or rehabilitation. Our facilities are backed by 91 years of reliable service to the water power industry. Why not let us help you with your project, whether it be expansion, rehabilitation or a new installation?



Field Test Results

1082

FOUNDED IN 1862

THE JAMES LEFFEL & CO.

DEPARTMENT C • SPRINGFIELD, OHIO, U.S.A.

MORE EFFICIENT HYDRAULIC POWER FOR 91 YEARS

THE CASE OF THE PHANTOM TRACTOR THAT PULLS IN REAL PROFIT!

Ask any progressive owner or operator why he equips his tractor with a Hyster Towing Winch. He'll say, "It's almost like having a second tractor up ahead all the time... ready to help you when you need it most." That's another way of saying Hyster Winches greatly increase tractor uses for more profit.

Hyster Winches increase tractor pull up to 92% over drawbar pull!

Full tractor engine power can be extended the length of the winch-line. Permits tractor to reach out and rescue stuck equipment, pull in logs or heavy objects. Saves time and keeps jobs going in all kinds of weather.

Matched Design of Caterpillar-built Tractors and Hyster Winches provides proper balance to develop maximum tractive effort—with good operating stability and maneuverability.

Only Caterpillar-Hyster has *truly-matched* tractors and winches. Yes, and *only* Hyster has 19 models and sizes of winches to fit all Caterpillar-built tractors and for all types of winch jobs.

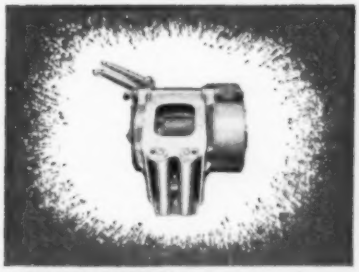
THERE'S PROFIT IN HYSTER POWER

Ask your Caterpillar-Hyster Dealer for the *right* winch to increase the profit on your job, or write to:

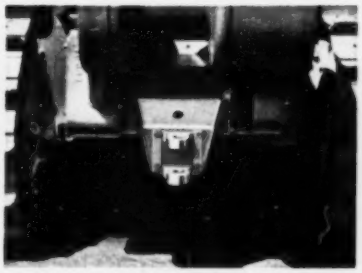
HYSTER COMPANY
2999 N. E. Clackamas . . Portland 8, Ore.
1899 N. Adams St. . . . . Peoria 1, Illinois

THERE ARE OVER 40,000 SATISFIED HYSTER WINCH OWNERS!

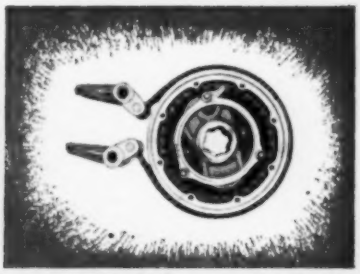
HYSTER TOWING WINCH ATTACHMENTS and FEATURES INCREASE WINCH EFFICIENCY and USEFULNESS



FAIRLEAD ASSEMBLY saves time maneuvering the tractor into yarding position. Reduces wear to winchline and tractor crawler assembly and saves fuel. Permits yarding from any angle to the rear of the tractor without the necessity of leading winchline straight from load to drum. (Optional for Models D8L, D7N, D6N)



BUILT-IN DRAWBAR provides added strength and rigidity to withstand severe vertical stresses encountered in arch logging and certain types of heavy-duty service. Yoke can be set in swiveling or non-swiveling (fixed) position. (Standard equipment on Model D8L, optional on D7N, D6N)



AUTOMATIC BRAKE, of special patented design, permits operator to pre-set brake before winching in a load—eliminates need for close coordination in controlling brake and clutch. For added safety, all brakes can hold loads greater than winchline capacity. (Optional on Models D8L, D7N, D6N)

HYSTER... the most complete line of tractor winches on the market!

NEW Transite®

provides

2.
2.
1.
3.
This cut-away* section shows:
1. Pipe ends automatically separated for flexibility and expansion.
2. Rubber rings compressed for water-tightness.
3. Coupling and pipe made of long-lived corrosion-resistant asbestos-cement Transite.

INSTALLATION OF TRANSITE RING-TITE COUPLING IS SURE, SIMPLE, EASY

A. Rubber rings in groove before assembly

B. Rubber rings compressed after assembly

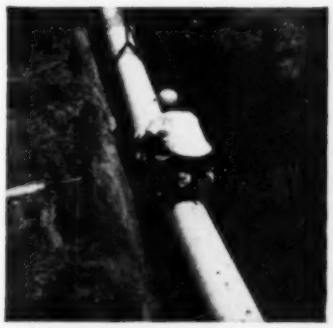
* **NOTE:** In the large photograph above, a portion of the Ring-Tite Coupling has been removed to show its design. One rubber ring has been cut to illustrate how it is compressed between pipe and coupling.

Johns-Manville

RING-TITE® Coupling

greater economy in pipeline installation ... maximum performance in service

- **Simplifies Transite Pressure Pipe assembly**
- **Reduces installation time**
- **Helps assure tight, flexible joints**



Here on this 12" New England installation of the Ring-Tite Coupling, the contractor's bid was based on installing 400 feet per working day for the job conditions prevailing. Actual laying time averaged over 700 feet per day!

Because of its unique design, the new Johns-Manville Ring-Tite Coupling provides many money-saving advantages. For example, no complicated equipment is required for line assembly. With tight, flexible Ring-Tite joints easily obtained, the contractor can get in and get out quickly with a substantial saving of time and money.

Ring-Tite Coupling installations can be made under adverse weather, temperature, or terrain conditions. Loose sand, slippery clay, mud and ice do not interrupt pipe assembly nor affect the performance of the completed assembly. Transite Pressure Pipe and Ring-Tite Couplings can be assembled in wet trenches.

Rings automatically positioned and locked in place

Pipes need only rough aligning. The coupling does the rest automatically . . . centers, aligns and adjusts for expansion. Rings are automatically pre-positioned by simply "popping" them into prepared grooves . . . and when the pipe is being pulled, the sliding motion of the rings squeegees all loose foreign material from the end of the pipe.

Each Ring-Tite Coupling is automatically stopped in exactly the correct sealing position to assure maximum water tightness and joint flexibility . . . to permit conformance to curves . . . to withstand shock and vibration . . . to relieve line stresses.

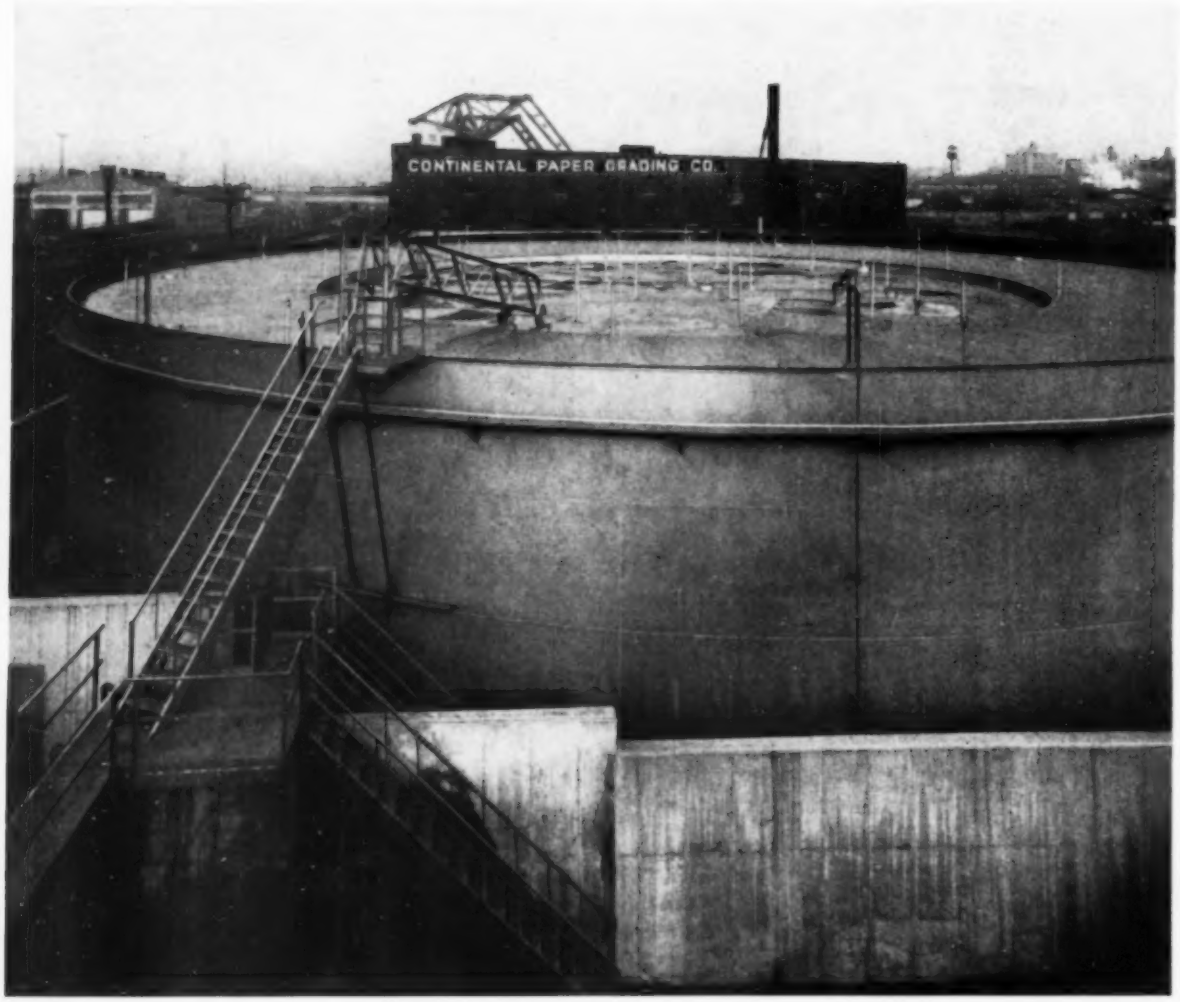
As a long-term investment, Transite Pressure Pipe effects outstanding performance and economies in your water supply and distribution expansion programs. Now the Ring-Tite Coupling brings you equally substantial *installation* economies—*immediate* savings!

For further information, write Johns-Manville, Box 60, New York 16, N. Y.

Actual experience on this New Jersey installation by a prominent water works utility established entirely new concepts of installation savings effected by the Ring-Tite Coupling. On the job shown, 600 feet of pipe were laid in 5 hours.

TRANSITE PRESSURE PIPE

JOHNS-MANVILLE JM PRODUCTS



Oil Storage in Metropolitan Areas

The storage of combustible liquids in metropolitan areas presents several unique problems. Uppermost, however, is fire hazard!

The Pennsylvania Railroad Company eliminated the fire hazard at its 18th Street river terminal in Chicago, Illinois, by equipping two 56,400-bbl. fuel oil storage tanks with Horton Pontoon Floating Roofs. The entire bottom of a Horton Pontoon Floating Roof is normally in contact with the liquid in the tank. There is no space above the liquid for a combustible air-vapor mixture to form. Evaporation loss and corrosion are also reduced by the elimination of the vapor space.

There are three types of Horton Floating Roofs—Double-Deck, Pontoon and Pan. All have been approved by Underwriters Laboratories, Inc. A copy of their report is available by writing our nearest office . . . as well as information, estimates or quotations on any Horton Floating Roof. There is no obligation on your part.

Field Welding Supervision

Every welded steel structure we build has a Field Welding Supervisor assigned to it during its construction to make *sure* it meets all specifications. Although independent of the Foreman in charge of a job, the Supervisor assists him in every way possible. He supervises the cutting and grading of plugs, checks welding equipment, helps qualify welders and assists with magnafluxing, x-raying or stress-relieving if required by the specifications.

C B & I Field Welding Supervision Service is provided on every welded structure we build at no extra cost . . . to assure you of the best tank your money can buy!

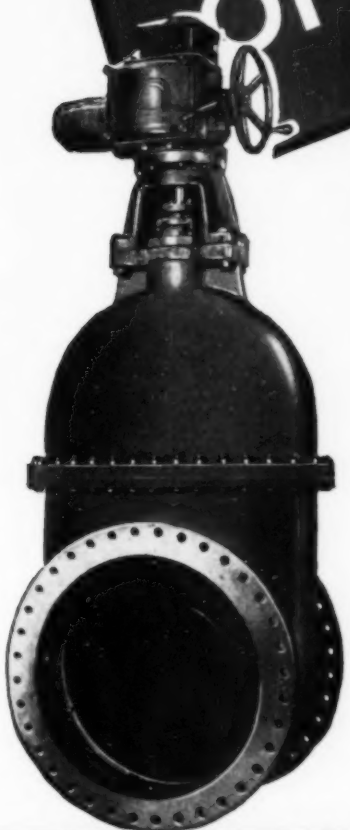
CHICAGO BRIDGE & IRON COMPANY

Atlanta 3 . . . . . 2167 Healy Bldg.
Birmingham 1 . . . . . 1596 N. Fiftieth St.
Boston 10 . . . . . 1009—201 Devonshire St.
Chicago 4 . . . . . 2199 McCormick Bldg.
Cleveland 15 . . . . . 2263 Guildhall Bldg.
Detroit 26 . . . . . 1541 Lafayette Bldg.
Havana . . . . . 402 Abreu Bldg.
Houston 2 . . . . . 2128 C & I Life Bldg.
Los Angeles 17 . . . 1556 Gen. Petroleum Bldg.
New York 6 . . . . 3395—165 Broadway Bldg.
Philadelphia 3 . . 1652—1790 Walnut St. Bldg.
Pittsburgh 19 . . . . . 3210 Alcoa Bldg.
San Francisco 4 . . . . . 1584—200 Bush St.
Seattle 1 . . . . . 1309 Henry Bldg.
Tulsa 3 . . . . . 1647 Hunt Bldg.

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNA.

SAFE
SURE
FAST
EASY

VALVE OPERATION



Get all 4 with
LIMITORQUE

For remote or local control . . . positive, speedy, safe, dependable opening and closing of all types of valves up to 120" diameter . . . equip with Limitorque. *Just pushing a button sets them in operation.*

They provide complete safety in two ways: First, they protect the workmen by eliminating the need of climbing to high or hazardous locations for manual valve operation. Second, they protect the valve operating parts by assuring a tight valve closure without overload on disc, seating rings or valve stems . . . and by automatically shutting-off the motor if foreign obstructions are met during the closing cycle.

Limitorque is actuated by any available power source . . . electricity, air, water, gas or oil.

Your valve maker can supply Limitorque Controls.

For complete details about Limitorque, send for Catalog L-50.

Philadelphia Gear Works, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.
NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA.

Industrial Gears and Speed Reducers
LimiTorque Valve Controls

Making the best still better

Sounds impossible, doesn't it . . . improving the cast iron pressure pipe that has served so many communities so long and so faithfully?

But the fact remains: today's modernized cast iron pipe is better than ever . . . stronger, tougher, more uniform in quality . . . even more economical and efficient than the cast iron pressure pipe that serves . . . and has served . . . for centuries.

And that is exactly what today's *modernized* cast iron pipe offers the waterworks industry. Cast centrifugally for greater strength and toughness. And, where needed and specified, cement-lined centrifugally for sustained carrying capacity and freedom from tuberculation.

If you want the most efficient and economical pipe ever made for water distribution, your new mains will be laid with *modernized* cast iron pipe with either bell-and-spigot or mechanical joints. Cast Iron Pipe Research Association, Thos. F. Wolfe, Managing Director, 122 So. Michigan Ave., Chicago 3.

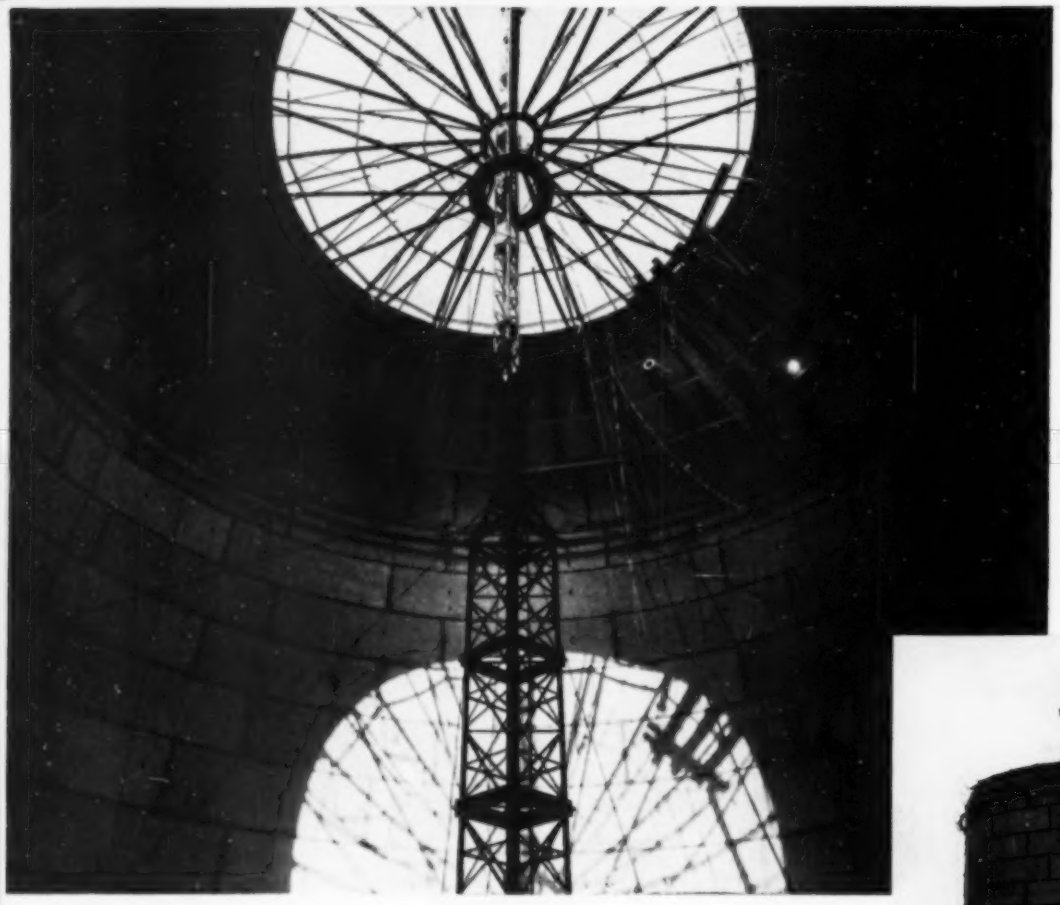
CAST Q IRON

The Q-Check stencilled on pipe is the Registered Service Mark of the Cast Iron Pipe Research Association.

Modernized **cast iron**

This cast iron water main, uncovered for inspection, is in good condition after 100 years of service in Alexandria, Va.—one of more than 45 cities with century-old water or gas mains in service.

pipe for Modern Waterworks Operation



Interior view—7,200,000-gallon steel reservoir under construction in the Pittsburgh district, showing roof framework before center course of roof plates was completed.

Exterior of the South Pittsburgh Water Co. reservoir, during construction. Unit is 116 feet in diameter, with 95 feet head range.

Pittsburgh • Des Moines

Steel Construction FOR WATER STORAGE

An important part of our steel construction activity is concerned with modern water storage for municipalities and industries throughout the country. Our three complete fabrication plants, skilled erection forces, and over half-a-century of design and construction experience are at your service for Elevated Steel Tanks, Reservoirs and Standpipes in all capacities. Write for consultation and quotations.

2,500,000-gallon radial cone elevated steel tank under erection for South Pittsburgh Water Co., showing tubular columns, riser and several radial girders in place. Tank is 112 feet in diameter; head range 35 feet; height to high water line 165 feet.

PITTSBURGH • DES MOINES STEEL CO.

Plants at PITTSBURGH, DES MOINES and SANTA CLARA

Sales Offices at:

PITTSBURGH (25) . . . . . 3470 Neville Island
NEWARK (2) . . . 251 Industrial Office Bldg.
CHICAGO (3), 1274 First National Bank Bldg.
LOS ANGELES (48), ... 6399 Wilshire Blvd.
DES MOINES (8), 971 Tuttle Street
DALLAS (1), 1275 Praetorian Bldg.
SEATTLE . . . . . 578 Lane Street
SANTA CLARA, CAL., 677 Alviso Road

From this Link-Belt 850-ft. long belt conveyor, raw materials for stockpiling near gravel preparation plant are discharged by Link-Belt tripper onto wing conveyor.

TOTAL ENGINEERING

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BELT conveyor efficiency begins with correct analysis of overall system requirements. And right from the start Link-Belt offers you unique advantages. Our engineers can apply broad experience to your bulk handling problems.

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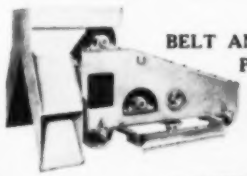

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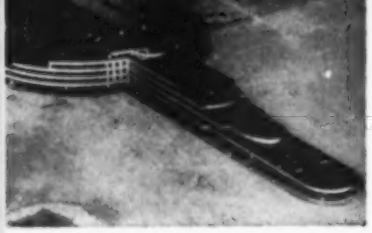

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American Bridge fabricated and erected the 4,000-ton steel framework for this huge structure which is 460' feet in breadth at its widest point, and with its 578-ft. loading dock has an over-all length of 979 feet. Nine months after the erection crew took over, the last rivet was driven.

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Most of the Cast-in-Place Piles on the New York Thruway are COBI PILES being driven by C. L. Guild Construction Co., Inc.

A paragraph from a story on the New York Thruway in ENGINEERING NEWS-RECORD of July 16, 1953

"A short distance farther, C. L. Guild, of East Providence, R. I., is driving cast-in-place piles with a pneumatic mandrel that expands inside the casing, transmitting driving force to the casing wall by friction (ENR Jan. 11, 1951, p. 35). (Most of the cast-in-place piles for thruway bridges are being driven by this method.) Guild is subcontractor for B. Perini Sons, Framingham, Mass., at this location."

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GENERAL CONTRACTOR	HOME OFFICE	NO. OF CONTRACTS	TOTAL FOOTAGE (ENGINEERS ESTIMATE)
D. W. Winkelman Co. Inc.	Syracuse, N. Y.	5	86,750
The Lane Construction Corp.	Meriden, Ct.	3	153,700
B. Perini & Sons, Inc.	Framingham, Mass.	1	70,050
Bero Eng. & Const. Co.	Buffalo, N. Y.	3	17,018
Potter-Dewitt, Inc.	Pavilion, N. Y.	2	16,361
Dan Bar Contracting Co. & W. E. O'Neil Constr. Co.	Syracuse, N. Y.	3	27,576
L. G. DeFelice & Son, Inc.	North Haven, Ct.	1	64,100
D. V. Frione, Inc.	New Haven, Ct.	1	22,260
Brunalli Construction Co.	Southington, Ct.	1	15,292
H. L. Baughman, Inc.	Rochester, N. Y.	2	22,261
Arute Bros., Inc.	New Britain, Ct.	1	9,895
A. S. Wikstrom, Inc.	Skaneateles, N. Y.	1	8,742
The Savin Constr. Corp.	Hartford, Ct.	1	1,508
Hogeboom & Campfield, Inc.	New Hartford, N. Y.	1	10,200
Grandview Construction Co.	Mount Vernon, N. Y.	1	6,300
Howes & Farrell, Inc.	Oneida, N. Y.	1	11,390
S. A. Scullen, Inc.	Waterford, N. Y.	1	9,000
			552,403

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42,400 copies of this issue printed

CIVIL ENGINEERING

OCTOBER 1953

THE MAGAZINE OF ENGINEERED CONSTRUCTION

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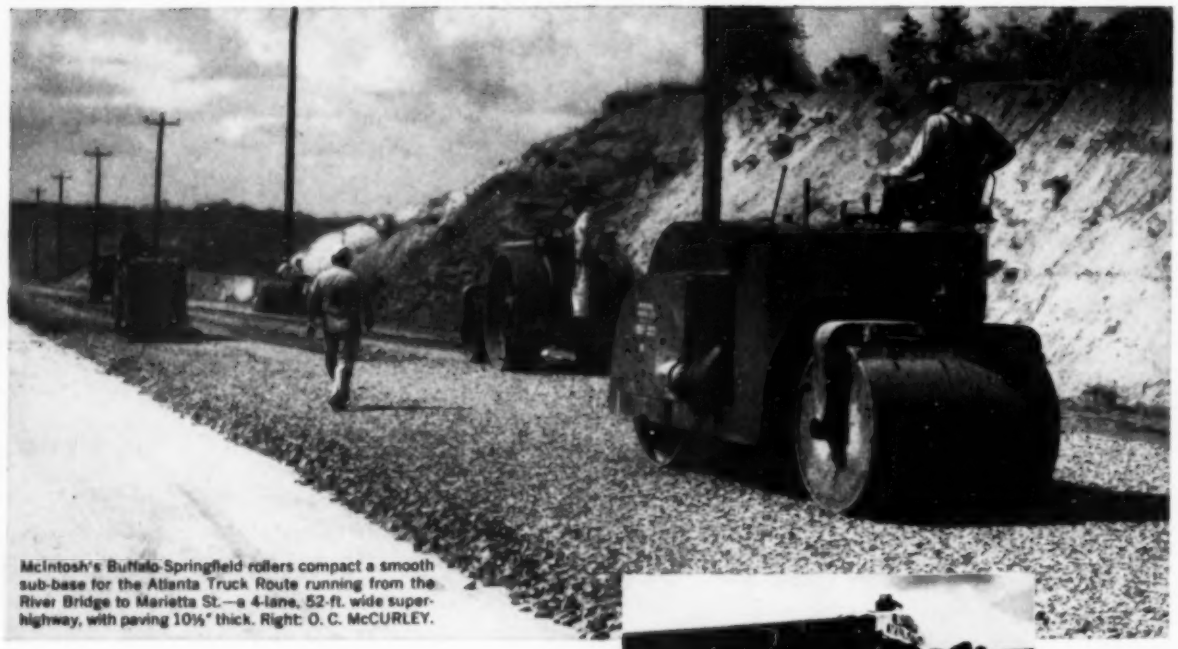

McIntosh's Buffalo-Springfield rollers compact a smooth sub-base for the Atlanta Truck Route running from the River Bridge to Marietta St.—a 4-lane, 52-ft. wide superhighway, with paving 10½" thick. Right: O. C. McCURLEY.

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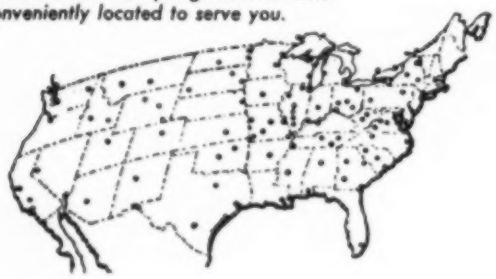

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CIVIL ENGINEERING

OCTOBER 1953

THE MAGAZINE OF ENGINEERED CONSTRUCTION

Built in 1750, Connecticut Hall on Yale University campus had suffered dangerous deterioration of interior timber construction. Exterior shoring was used to support brick walls while interior was replaced by steel frame.

New frame, old face, for Yale's Connecticut Hall

CHARLES B. SPENCER, M. ASCE, President, Spencer, White and Prentis, Inc., New York, N.Y.

Connecticut Hall, built in 1750, is the oldest building on the Yale University campus, and is considered an outstanding example of the architecture of its period. The exterior is of brick, probably brought from Europe as ballast. The brick varies in color, but the general effect is pleasing.

Interior floor construction consisted of hand-hewn oak timbers spanning about 40 ft across the building, but supported by center posts and notched to receive longitudinal joists. Much of this wood construction had deteriorated over the years to the point where none of the floors were safe for occupancy. The roof, which had been restored in 1905, was in good condition.

Similarity to White House Noted

The architect engaged for the restoration of the building was Douglas Orr, who had served as vice-chairman of the White House Restoration Commission. He was quick to see the similarity between the condition of Connecticut Hall and that of the White House, and called in Spencer, White and Prentis, Inc., to verify his conclusion that a similar renovation procedure should be used. (See "The White House Made Safe," by Richard E. Dougherty, CIVIL ENGINEERING for July 1952.) The engineers of this company, who had performed the work on the White House, concurred in the practicability of Mr. Orr's plans.

In the case of the White House, the shoring of the building and the underpinning of the exterior walls was awarded to this company on a noncompetitive basis, in accordance with an Act of Congress. Demolition was done by the general contractor, and erection of the steel frame was awarded to a steel contracting firm on a competitive basis.

In the case of Yale's Connecticut Hall, it was felt that it would be better to avoid a divided responsibility. Therefore the shoring, demolition, underpinning, new foundations, and steel erection, together with the transfer of all loadings to the new steel frame, were included in one contract. This was awarded to Spencer, White and Prentis, Inc., and work was started in February 1953.

As in the case of the White House, when the defective interior construction was removed, the exterior walls would be free standing and would require lateral support to prevent toppling. In the White House this support was provided entirely inside the building, in the form of a series of transverse tension and compression members supplemented by diagonal sway bracing, all of structural steel. This shoring and bracing greatly complicated the erection of the new steel but was the only method practicable under the circumstances.

Since Connecticut Hall is a much smaller building, it was found more practicable to use inclined shores on the outside, engaging vertical beams to which the exterior walls were tied. These steel frames were connected through the building by horizontal structural-steel members at the fourth-floor level. Complete rigidity was thus attained. The horizontal members served the additional purposes of providing support for the attic floor and of aiding in the erection of the new steel. On completion of the shoring, and before demolition was started, the horizontal thrust of the gambrel roof bents was provided for by installing a series of transverse steel tie-rods 10 ft on centers.

↑ Horizontal beams took thrust of exterior shoring and also provided added support for attic floor and aided in steel erection. Steel tie-bars (top of photo) took horizontal thrust of gambrel roof bents.

← Interior chimneys were left standing during erection of steel, although plans called for their eventual demolition below attic floor. Completed steel frame was used to take load of top of chimney before demolition of lower part began.

At the White House, the demolition of the interior was complicated by the fact that much of the salvaged material had to be carefully preserved for reuse or for souvenirs. At Connecticut Hall, to save time and expense, it was decided not to salvage any of the material. Actually, certain old doors and mantels, together with a quantity of hand-cut nails, were saved, but this was not an important item.

As the work progressed, it was found that the interior portions of the brick walls were extremely soft. If, as has been suggested, the exterior brick was imported, it is probable that the available quantity was inadequate and had to be supplemented by local brick greatly inferior in quality.

Foundation Soil Found Adequate

Fortunately there was no question as to the adequacy of the soil at the existing basement level. There was no evidence of settlement in the walls, and the new design called for the conservative unit loading of 2 tons per sq ft on a moderately compact sand.

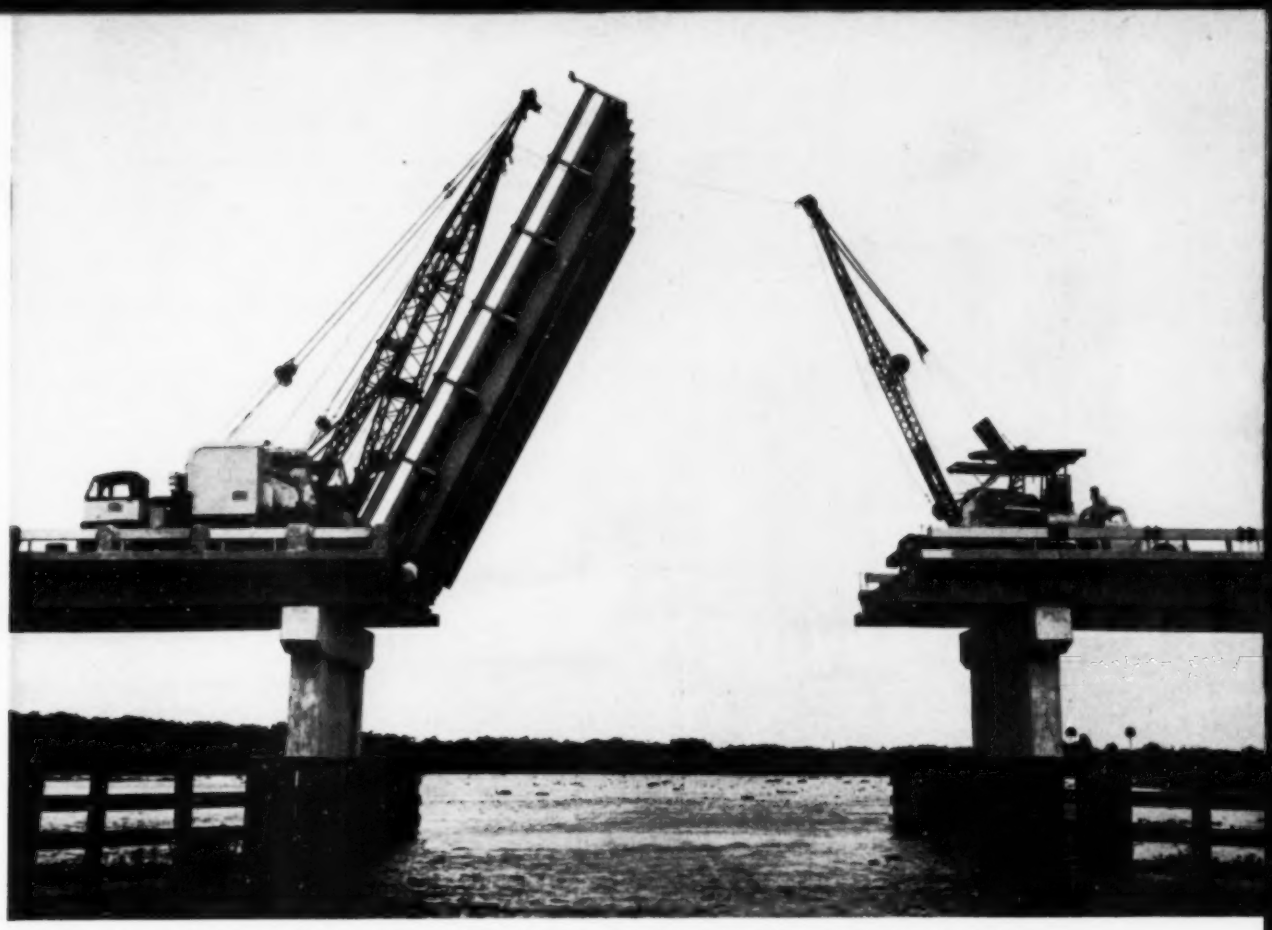
To provide additional headroom, the cellar grade was lowered about 18 in. The cellar space however was not considered of sufficient value to warrant a complete underpinning operation, so generally the walls were left on their original footings, and protected by stub retaining walls against the deeper excavation in the new cellar. The only underpinning required was at the new exterior column foundations, which projected beneath the walls, and at the four chimneys, two at each end, which were left in place.

The two center chimneys demanded special consideration. They were actually independent structures and fortunately in good condition. The design called for their demolition below the attic floor level, and because of the weights involved, shoring would have been hazardous and expensive. It was decided therefore to leave them in place during steel erection, and then finally to transfer the loadings of the upper portions to the new steel, after which the lower portions could be demolished.

Steel specifications called for bolted field connections, and steel erection was comparatively simple. Of course it was a hand job and required great care because of the condition of the walls and the presence of the chimneys. As previously stated, erection was greatly facilitated by use of the cross members of the shoring system.

In the case of the White House, the exterior walls were anchored to the new construction by means of dowel rods, set in holes drilled in the walls and extending into the concrete of the various floors. On Connecticut Hall however, the inferior quality of the brick work made this impracticable, since the installation of the dowels would have been difficult and their value under the circumstances very questionable. Instead the walls were anchored by carefully cleaning out the bearing pockets for the original wood beams and filling these cavities with concrete poured monolithically with the new concrete floors.

The restoration of Connecticut Hall, which may well set a precedent for the salvaging of other important historical structures weakened by the ravages of time, was accomplished by Spencer, White and Prentis, Inc., contractors for the work described above, and by the Paterson Construction Co., Inc., general contractors. Douglas Orr, assisted by Richard H. Fletcher, was the architect, and Henry Pfisterer, the consulting engineer.



Hinged movable span on Kissimmee River Bridge offers simple solution to problem of providing for infrequent opening of highway bridges in drainage and flood control system of south-central Florida. Vessels, chiefly dredges, can be snubbed through, using fenders for moorings.

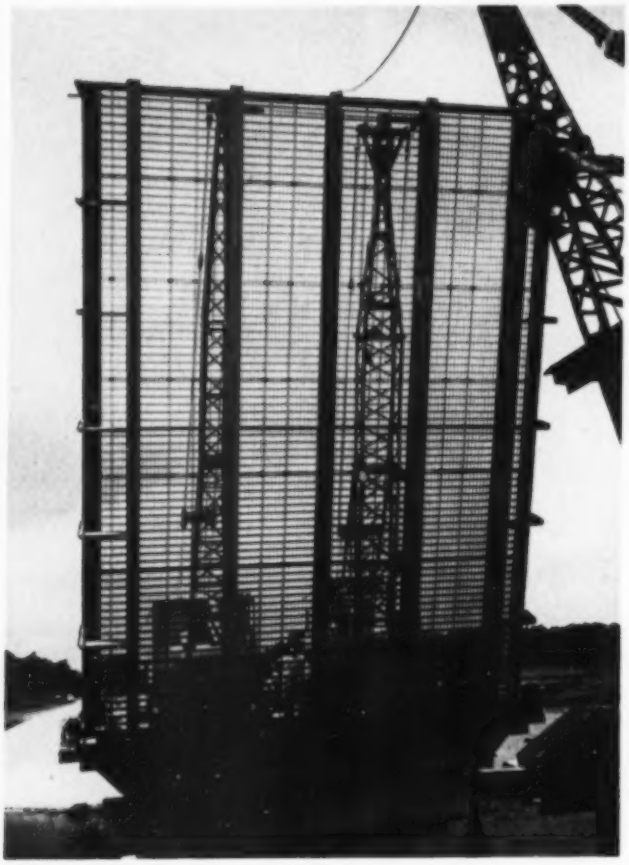
Hinged spans for rarely opened bridges over Florida drainage canals

W. E. DEAN, JR., M. ASCE, Engineer of Bridges, State Road Department, Tallahassee, Fla.

The utilization of hinged movable spans for infrequently opened highway bridges has provided a simple solution to an annoying problem encountered during the expansion of the drainage and flood control system in south-central Florida. This area around Lake Okeechobee is covered by a network of waterways constructed by the Everglades Drainage District and now being extended by the Central and Southern Florida Flood Control District. These waterways were not designed for navigation, and the many highway bridges crossing them need no provision for the passage of commercial or pleasure craft. However, periodic passage of floating construction and maintenance equipment is required.

When the drainage and highway systems in this area were originally constructed in the early 1920's, most of the highway bridges were small, manually operated, single-lane draw spans with light live-load capacities. These structures served their purpose at the time of construction, but the large increases in both volume and weight of highway traffic that have since resulted from the development of truck farming and sugar operations have rendered them obsolete. Several of these structures have required rebuilding in recent years and the reconstruction of many more is imminent.

In reconstructing these bridges to carry increased loads the problem of providing for occasional openings remained. Although a bridge may not have to be opened more than half a dozen times in the course of its life, such openings can be definitely anticipated and provision for them



Light I-beam span has open-grid steel deck hinged at one end to adjacent span. Span measures 41 ft center to center of end bearings and has grid decking of 5-in. I-beam type.

Direct lift of 10 tons is required to raise free end of span. On Kissimmee River Bridge, largest structure of this type built to date, two $^{3}/_{4}$-yd truck cranes with 40-ft booms are placed side by side at hinged end of span and additional crane is used on free end.

must be made. Prohibitive expense or inconvenience ruled out two suggested solutions—the single-leaf bascule and the removable floating span. A single-leaf bascule span 28 ft wide, constructed according to current movable-bridge and live-load standards, would cost about $125,000 for the draw span alone, even with manual operation. As for the removable spans of the float-out type, the Florida road system includes a few of these but they are objectionable because of the time required for jack-up, float-out and replacement operations. It is difficult and expensive to mobilize suitable barge, tug and jacking equipment at isolated locations.

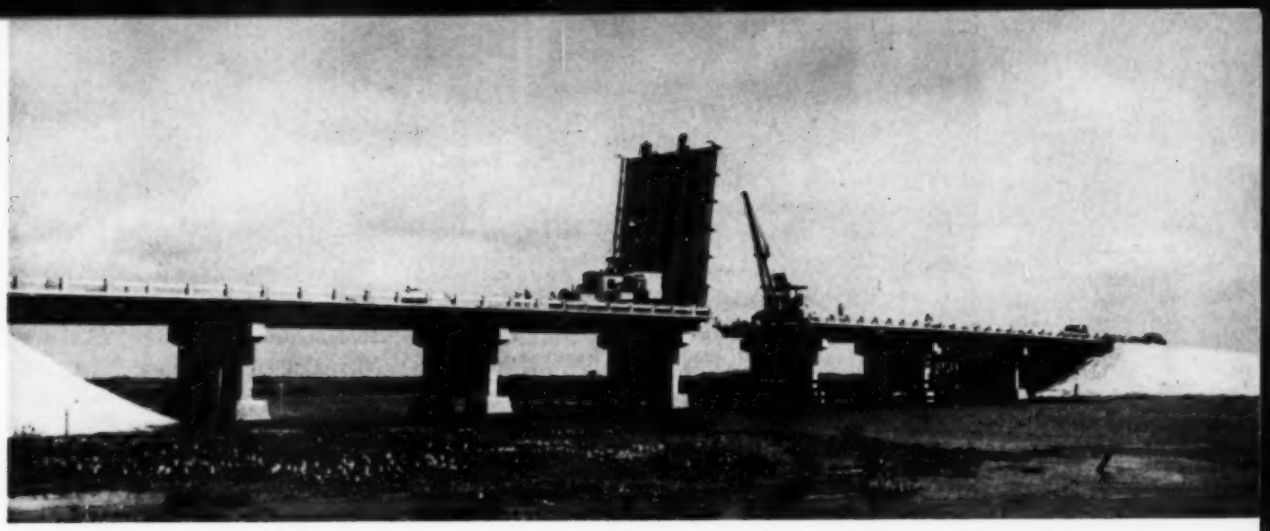
The bridge design adopted to solve this problem incorporates a light I-beam span with an open-grid steel deck, one end of which is hinged to an adjacent span. These movable spans are without counterweights or machinery of any kind and may be opened by two or more light truck cranes. The Road Department has several such cranes among its maintenance equipment continuously working in the vicinity. When a bridge is to be opened, a minimum notice of four days is required to get the cranes to the project. Once the cranes are at the site and the vessel to be passed is standing by, an hour or less should be sufficient to open the structure, pass the vessel, and return the bridge to position for use by highway traffic.

Since 1949, the Florida Road Department has constructed six of these bridges and four more are under contract. The Highlands County Bassenger Bridge over the Kissimmee River, completed April 10, 1953, is the largest of these spans constructed to date. Specific criteria for the structures have varied but the Kissimmee River Bridge is generally typical. It is expected that at least twice during its life this structure will have to pass a rather large dredge for waterway improvements upstream.

When closed, the span of the Kissimmee River Bridge provides a horizontal clearance of 50 ft between fenders and a vertical clearance of 20 ft above mean low water. It was agreed that a 36-ft horizontal opening in the deck would provide a reasonable clearance for the superstructure of a dredge. However, to provide for the passage of the dredge hull, a greater clearance between fenders had to be provided. This specification introduced an undesirable feature in the design because the supports for the movable span had to be cantilevered channelward from the fender faces. For the few times that a dredge will pass the structure it is considered practical to snub the vessel through carefully, using the fenders for moorings.

A layout and general details of the Kissimmee River Bridge are shown in Figs. 1 and 2. The movable span consists of a unit 41 ft long from center to center of end bearings with the 28-ft-wide roadway carried by five 24WF76 stringers (Fig. 1). To minimize the weight of the unit some liberties were taken with the ordinary AASHO specifications. The allowable stress in bending for the stringers was set at 22,000 psi and the spacing between stringers was made somewhat greater than that normally used for grid decking of the 5-in. I-beam type. Also, the diaphragms are lighter than those ordinarily used in fixed-span construction. The entire weight of the movable unit is approximately 39,800 lb.

A direct lift of 10 tons is required to move the free end of the span. Slightly lighter spans have been handled by two $^{3}/_{4}$-yd truck cranes with 40-ft booms placed side by side at the hinged end of the span. The booms are fully raised through the entire operation and the lift is accomplished by take-up of the cables. For the Kissimmee River Bridge, the 10-ton direct uplift, when turned through



the angle to the boom tips, is somewhat above the capacity of two cranes unless they are both outrigged and counterweighted. In this case, an additional crane was used on the front end of the deck span to start it up and to assist in the final lowering.

Details of the hinge are illustrated in Fig. 2. The $2^1/_2$-in. hinge pins are installed in $2^5/_8$-in. holes to allow a slight tolerance in installation. The span is assembled on its fixed supports first, after which the hinge plates on the adjacent fixed beams are lined up and welded and the pins installed to a loose fit. This procedure is followed to insure that there will be no stress on the hinges when the span is in closed position and subject to highway live loads. Steel bumper blocks on the backs of the hinges prevent the span from opening more than 85 deg.

The span, as constructed, costs little more than an ordinary fixed-trestle span. The design is, of course, limited to structures where very infrequent openings are required. While it may not be an ideal solution to the problem, it has been a very economical expedient for the Florida Road Department. For the six structures of this type completed within the past four years, the requirement for an opening provision was imperative, but not one has been opened yet except for required tests by the construction contractors.

It is estimated that each opening will cost from $200 to $300 depending on the distance from which equipment must be mobilized, but, considering the infrequency of opening, this cost is insignificant compared with the maintenance and depreciation of even the simplest type of conventional drawbridge.

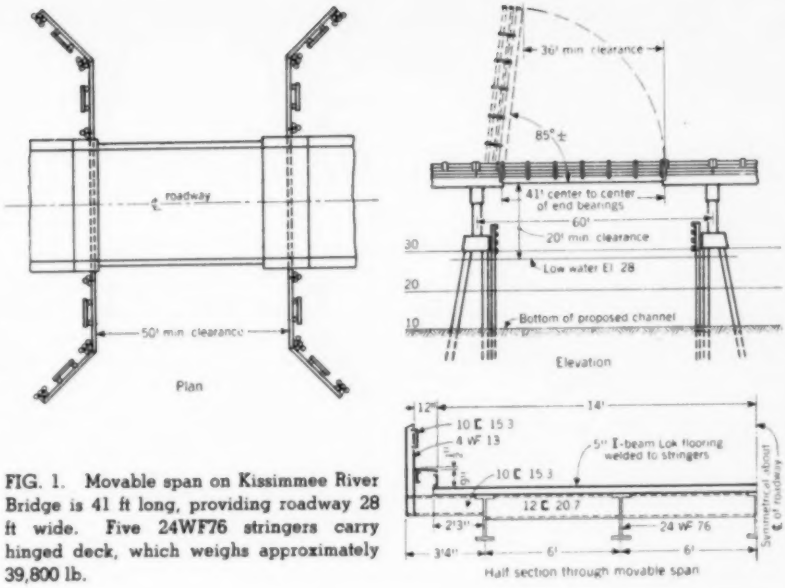


FIG. 1. Movable span on Kissimmee River Bridge is 41 ft long, providing roadway 28 ft wide. Five 24WF76 stringers carry hinged deck, which weighs approximately 39,800 lb.

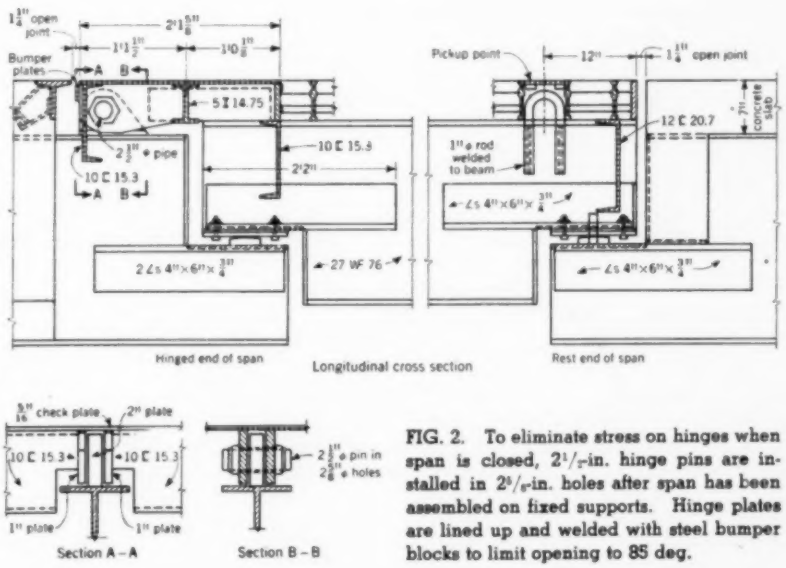
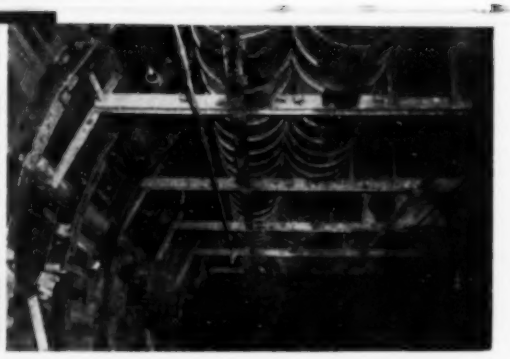


FIG. 2. To eliminate stress on hinges when span is closed, $2^1/_2$-in. hinge pins are installed in $2^5/_8$-in. holes after span has been assembled on fixed supports. Hinge plates are lined up and welded with steel bumper blocks to limit opening to 85 deg.

Ground was broken for shaft construction in July 1951 with driving of steel sheetpiles (left). As excavation was deepened, piling was driven to follow closely, with piling about 2 ft behind excavation. Upper section of shaft after being concreted is seen above.



View looking down shaft (above) shows two ventilation pipes of 48-in. diameter. On near side of shaft are guides for the two 14-cu yd skips. Cage 9 ft 3 in. × 22 ft, running in center of shaft, can carry bulldozer or ¾-cu yd shovel without dismantling.

Ontario Hydro blasts out Niagara power tunnels

Big equipment expedites excavation of twin tunnels 5½ miles long

All flows over Niagara Falls, above those required to provide an adequate scenic spectacle, were divided between Canada and the United States by treaty signed in October 1950. Canada is allowed an additional 5,000 cfs of water that Ontario Hydro diverts from the Hudson Bay drainage area. The treaty has enabled the Hydro-Electric Power Commission of Ontario to undertake a $343,000,000 power project which will ultimately develop 1,828,000 hp. The major phase of the project will be of 1,200,000-hp capacity, which will be in full operation in 1956. This article describes the driving of the twin pressure tunnels which connect the intake above the Falls with the new Sir Adam Beck Generating Station No. 2. (Concreting of these tunnels will be described by Mr. Glaeser in a later issue.) Each of these tunnels is 51 ft in excavated diameter and will carry 20,000 cfs for 5½ miles.

To utilize the United States' share of the Niagara water, three plans have been developed, as described in *Civil Engineering* for April 1952, page 32. As yet Congress has not given the necessary specific authorization to proceed either by privately operated utility companies, by the New York State Power Authority, or by the federal government.

For large size as well as for length, the twin tunnels now being built on the Canadian side to carry Niagara Falls water to the Sir Adam Beck Generating Station No. 2, are notable. This power development, being carried out by Ontario Hydro, will handle the major portion of Canada's share of the water available at Niagara Falls for power purposes. Major elements of the project, listed in the direction the water flows, are a gated river-control works, 2 miles above the Falls, intake works, two submerged gathering tubes each 500 ft long (one for each tunnel), deep twin pressure tunnels with entrances and outlets inclined 30 deg to the horizontal, 2¼ miles of open canal, the forebay structure, and a powerhouse some 6 miles downstream from the rapids. These are shown in Fig. 1. The Hydro-Electric Power Commission is using its own construction forces to build all elements of the project except the tunnels.

Construction of Tunnel No. 1 was let on the basis of a unit price bid,

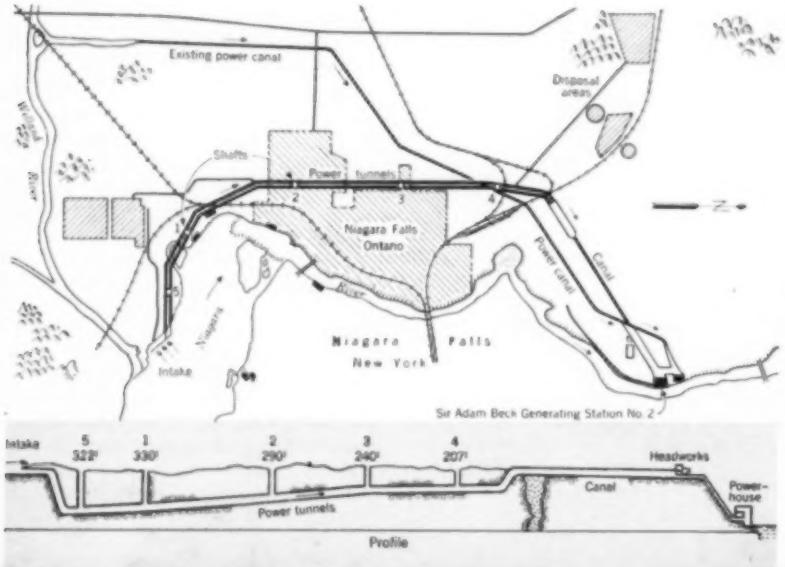


FIG. 1. Twin tunnels, of 20,000-cfs capacity each, are now being driven to connect intake above Niagara Falls with Sir Adam Beck Generating Station No. 2, all part of project to utilize Canada's share of excess Niagara Falls water. Profile below has exaggerated scale, making slopes at ends of tunnels look steeper than their actual 30-deg vertical curve.

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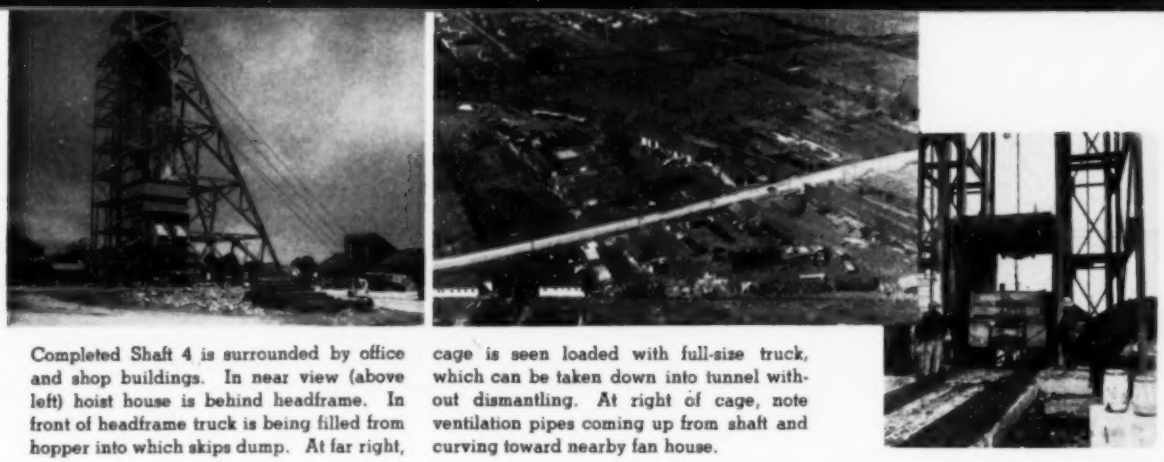


Completed Shaft 4 is surrounded by office and shop buildings. In near view (above left) hoist house is behind headframe. In front of headframe truck is being filled from hopper into which skips dump. At far right, cage is seen loaded with full-size truck, which can be taken down into tunnel without dismantling. At right of cage, note ventilation pipes coming up from shaft and curving toward nearby fan house.

# of 51-ft diameter

JESSE R. GLAESER, Vice President and Chief Engineer,

B. Perini & Sons, Inc., General Contractors, Framingham, Mass.

but Tunnel No. 2 was negotiated with each contractor having the adjacent No. 1 section. This was because delays in starting the power development made it necessary to proceed as quickly as possible with all the Niagara units.

Tunnel work consists of twin bores on 250-ft centers, each of 51-ft excavated diameter and a finished diameter of 45 ft when lined with concrete. Tunnel No. 1, following the outer course around the Niagara River, is 28,560 ft long, and No. 2, which follows the inner course, is 27,300 ft long, making a total tunnel length of 10.6 miles. Each tunnel is designed to carry 20,000 cfs.

Vertical Shafts Constructed

Construction is being carried out through five vertical shafts. This article concerns the work awarded to "B. Perini & Sons, Inc., Walsh Construction Co., and Canadian-American Contractors," forming the joint venture working the upstream section at Shaft 5, and the downstream sections at Shafts 3 and 4, each section representing approximately one-fifth of the whole.

Shaft 5, of 29-ft diameter, is 322 ft in depth from ground surface to tunnel invert, while Shafts 3 and 4, of 26-ft diameter, are 240 and 207 ft respectively. Shaft depths were determined by the depth of the 10-ft-thick stratum of Irondequoit limestone, selected as the most satisfactory rock structure to use for the tunnel roof (Fig. 2). All shafts were excavated to a depth of 71 ft below the tunnel invert grade to provide a pocket for the muck storage bin and the skip-loading mechanism.

Construction shafts are located near the mid-point between the main tunnels, and offset to one side of the access drift which connects both tunnels and is of similar size except for vertical sides below the springing line. Shafts were excavated to bedrock, at depths varying from 42 to 62 ft with sheetpiling and steel-ring wales. As the excavation was deepened, the piling and rings were driven to follow closely, with the piling about 2 ft in advance.

Through the rock the usual shaft sinking methods were used. Concrete rings 6 ft wide, and spaced 12 ft on centers, were installed to support the rock and to carry the attachment for the elevator guides. As soon as the access-tunnel roof was reached, the sinking drills were attached to air legs and an Eimco Rocker shovel was used for mucking.

Hoisting Equipment Installed

With the shaft completed, the permanent tunnel hoisting equipment was installed and put in service. Each shaft is equipped with a 9-ft 3-in × 22-ft-long counterbalanced cage, with 12-ft 0-in. clearance, and designed for a 20-ton working load. The cage runs in the center of the shaft, leaving a generous space on each side of its shorter dimension.

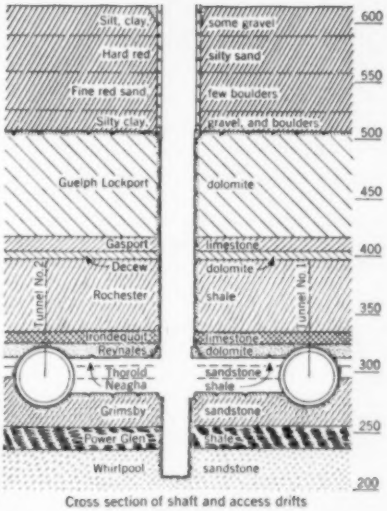
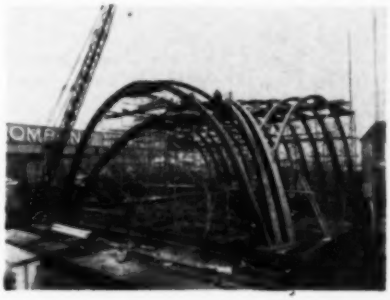
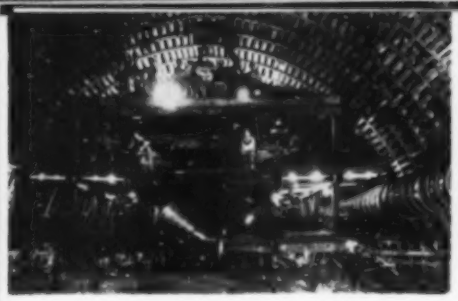
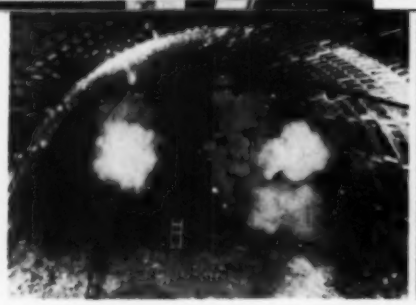


FIG. 2. Cross section through typical shaft shows pocket at bottom for muck storage bin and skip-loading mechanism, with cross drift giving access to both tunnels.



Groined arch steel support, for transition where cross drift meets tunnel, was set up on surface (above), then taken down and reassembled in tunnel (below), where temporary skid-mounted jumbo was used for turning corners into main tunnels.





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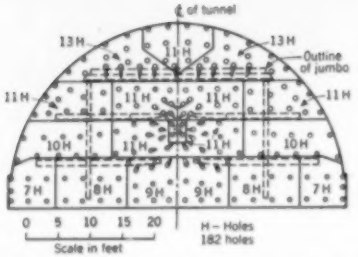
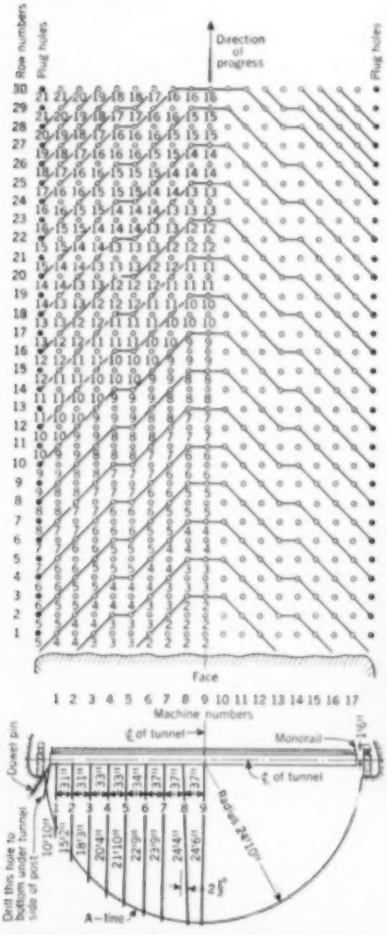


FIG. 3. To drive upper or heading section of tunnels, this drill pattern was used with heading jumbo shown in photo above. This view, looking toward completed heading section, shows face side of jumbo, and steel ribs and connecting reinforcing in place, with 48-in. ventilation pipe at right.

FIG. 4. Drill pattern for bench section of Tunnel No. 2 at Shaft 4 is typical of all patterns for blasting bench section of tunnels. Drilling machines are sloped 8 deg towards bench face. Numbers in drilling pattern indicate order of firing with millisecond delay detonators.



In this space on one side, the two 14-cu yd self-dumping skips run in balance. On the other side of the cage are placed the two 48-in.-dia ventilation lines, the four 8-in. lines (two each for air supply and pump discharge), and the single 3-in. water line.

Hoisting equipment at all shafts is identical. A 350-hp hoist handles the cage and counterweight and a 450-hp hoist operates the balanced skips—all at 350 fpm. The hoists were made by Lidgerwood-Mundy. All drums and sheaves are of 96-in. diameter, grooved for $2^1/_8$-in. cable. Headframes, designed to withstand the breaking strength of the $2^1/_8$-in. hoist cables, required a height of 120 ft, and a base dimension of 55 × 58 ft. Including the 120-cu yd muck bin, they weigh 250 tons. The headframes are a broad-top A-frame design with the head sheaves cantilevered over the shaft so that no heavy foundations are required in the immediate vicinity of the shaft collar. Cage and skips are guided to their extreme height by a light steel guide frame extending from the shaft collar to the cantilever.

This hoist layout has proved its worth by showing extremely high capacity and reliability. In a single six-day week, some of the major quantities handled by one hoist were 24,000 cu yd of solid rock, 1,000 tons of steel support, 125,000 fbm of timber, and 35 tons of explosives.

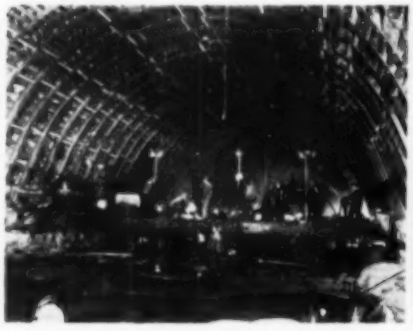
Upper Half of Tunnels Holed Through First

With the shaft completed, tunnel construction was immediately started, applying the method that had been decided on, that is, completing the upper or heading section before starting the bench section. Temporary skid drill jumbos, handled by a tractor and mounting 7 drills, were used to drive the access drift 125 ft each way from the shaft to intersect the main tunnels. This intersection was supported with groined steel ribs bearing on concrete foundations designed for a 10-ft dead load of rock.

The two permanent drill jumbos for the upper section of the tunnel were then installed. These jumbos were of three-deck steel construction mounted on 8 wheels riding on a 120-lb track of 28-ft gage. The rails were welded to continuous 18-ft 55-lb channels. Ample clearance was provided through the jumbo by hinging the inner sides of the two lower platforms of the jumbo so that they could be dropped down, to

Bench section was drilled with jumbo in shape of platform 10 × 50 ft riding on monorail carriages suspended from support steel by clamps and turnbuckles. Drilling pattern is shown at left.

In view of completely excavated tunnel, note concrete curbs on which rails for lining jumbo will later be placed. Also, it is possible to see ends of pins driven to help support timbers under roof steel.



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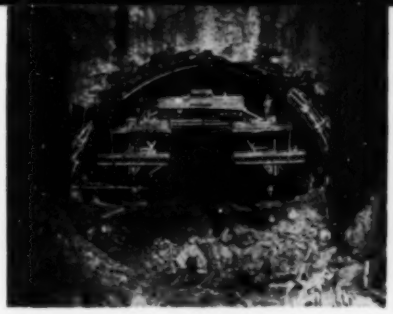
Note excellence of muck, which was removed by electrified Northwest 80 D shovel loading into 11.4 cu yd rear-dump diesel Euclids (above left). Completed heading section with steel support in place is seen above right.



Heading jumbo emerges, having completed drilling for top portion of inclined end section of tunnel. Jumbos used on inclined sections resembled those used on flat parts of tunnels but were adjusted so that platforms would be horizontal, and strengthened to take increased stresses. Movement up slope was obtained by two 50-ton winches. (All photos are by Ontario Hydro.)

permit the passage of all mucking equipment. While mucking was in progress, an elevator at the rear of the jumbo lifted all material required for drilling the next round and for supporting the roof rock exposed by the previous shot.

Drilling equipment on each jumbo consisted of 19 Joy T-350 wet-type drifters. These are chain feed with an 8-ft carriage, enabling drill-steel changes to be made in 8-ft lengths. All were mounted on Joy hydrodrill jibs with power lift and swing, hydraulic pressure being supplied by a Joy unitized air-operated pumping system.

The headings, having a volume of 44 cu yd per lin ft (full section 76 cu yd), were drilled with $1^1/_4$-in. hollow round drill steel using Timken tungsten-carbide insert detachables, kept sharp by grinding. Some Liddecoat throw-away bits were used. All drill steel for each round is removed to the surface for complete check so that each drilling cycle loses a minimum of drill time. The holes varied in number from 140 to 182, and in depth from 16 to 24 ft. Although a set pattern was established (Fig. 3), leeway was allowed to balance the work at alternate headings and to allow for difficulties encountered in scaling the face and roof. The most workable round was one having 182 holes with a 7-hole burn cut in the center of the face. Rib holes 20 ft deep, with 22-ft relievers, pulled in excess of 18 ft. This round provided muck which was not too difficult to pass through bins and gates and made a muck pile of sufficient height to facilitate scaling of the roof rock.

Canadian Industries supplied Drift-tite in $1^1/_4$-in. × 8-in. sticks and also 1- to 15-millisecond delay exploders with wires 24 ft long; $2^3/_4$ lb of powder were used per cu yd of solid rock along with 0.4 of an exploder.

Blasted rock at the tunnel faces is loaded by electrified Northwest 80 D shovels into 11.4-cu yd rear-dump diesel-driven 87 FD Euclid trucks. Trucks utilized below ground on a permanent basis were equipped with exhaust scrubbers. The shovels are equipped with short booms and dipper sticks, and with $3^1/_2$-cu yd dippers. Muck is hauled to the grizzly-covered skip loading pocket below the shaft bottom, and dumped into a 750-cu yd guillotine-gated storage bin. This bin discharges into two 12-cu yd measuring bins holding a skip load each.

After being hoisted to the surface the skips dump into the 120-cu yd muck bin in the headframe tower previously described. The muck bin discharges into 16-cu yd Marion trailer dumps, pulled by F 8 Fords, which haul the muck one to two miles to designated disposal sites. With easy grades on good haul roads, this equipment proved extremely satisfactory.

In spite of the generally excellent roof formed by the Irondequoit limestone, the weak Reynalis dolomite and Neagha shale beds underneath it (Fig. 2) made continuous roof support necessary.

The support consists of steel-rib sets spaced 4 ft on centers, supported by wallplates with bearing 10 in. above the springing line, on 12 × 12-in. timber posts 4 ft long. The ribs are H-beams weighing 43.64 lb per ft, a European section of 7.87 in. The wallplates were made up of two 10-in. 35-lb I-beams. A complete rib assembly was fabricated in four pieces, and the wallplates in 16-ft lengths. The ribs were held on 4-ft centers by $^3/_4$-in. round tie-rods and 4 × 6-in. timber spreaders, 12 to the set. The sets were blocked with timber ranging from 2 × 6 in. to 8 × 6 in. Outside the sets the rock was supported by the same sizes of timber precut to a 5-ft length and placed as required, or by cribs where necessary.

Between the ribs, steel lagging fabricated in 4-ft lengths was attached with carriage bolts and clips. Originally 6-in. 7-lb channels, with 2 in. between them, were used for this purpose, but after some experimentation it was discovered that a 12-in. 10-gage. pressed plate, which had about half the weight per sq ft, was equally satisfactory. Supporting steel ranged from 1,350 to 1,750 lb per ft of tunnel, depending on the type of lagging used. The timber requirement, including posts, spreaders, blocking and rock support, averaged 225 fbm per ft of tunnel.

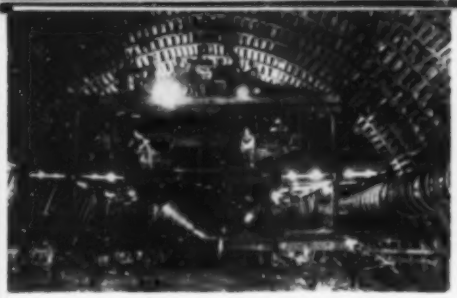
Headings were advanced on an alternating basis. The tunnel crew consisted of one drill, one muck, and one support crew per shift. Each completed its cycle of work in one heading and then moved to the opposite one. Since the support steel was placed during the drilling period, the support crew moved with the drill crew. Best progress on the heading totaled 531 ft in six three-shift days in March 1953, made by the above arrangement of crews alternating in two headings.

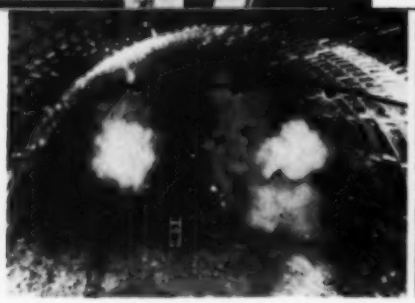
Bench Excavated Last

Bench excavation was started only after the upper or heading section had been completely holed through and the bottom thoroughly cleaned. The mucking equipment used was the same as for the upper section.

Instead of using the conventional wagon drill or horizontal drilling for the bench excavation, it was decided to use a jumbo arrangement. This rig is essentially a platform 10 × 50 ft, spanning the tunnel and riding on monorail carriages suspended from the support steel by clamps and turnbuckles. The drill mounting consists of a $3^1/_2$-in. pipe attached to the long edge. Movement and position are obtained by using tuggers for both pulling and snubbing. The elevation of the jumbo is fixed by attaching the hangers at a definite distance above the wall-plates.

With the jumbo set at correct line and grade, a drill is mounted for each hole to be drilled in any jumbo position, using the same drills previously used on the heading jumbo. Holes





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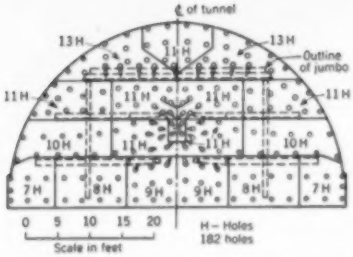

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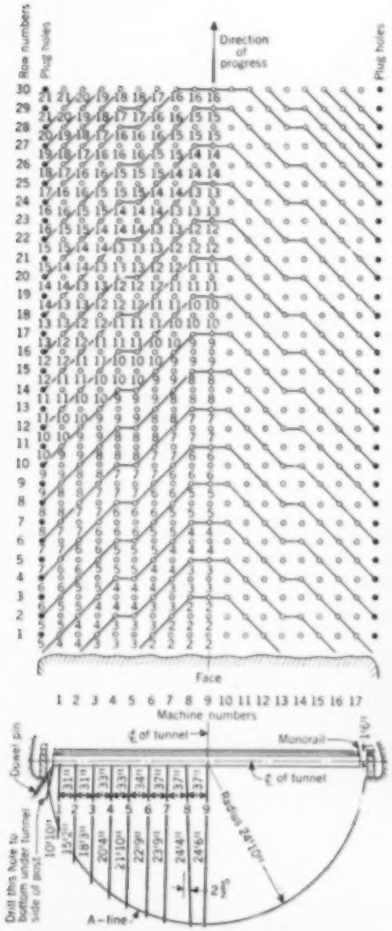

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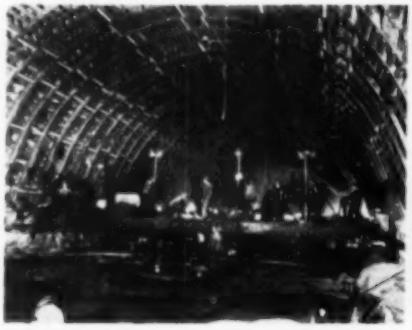

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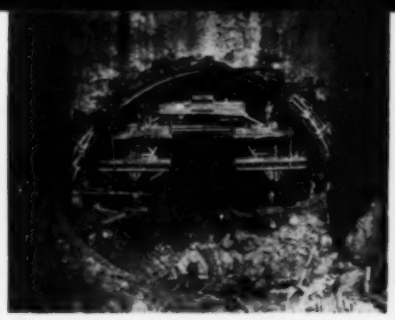


Heading jumbo emerges, having completed drilling for top portion of inclined end section of tunnel. Jumbos used on inclined sections resembled those used on flat parts of tunnels but were adjusted so that platforms would be horizontal, and strengthened to take increased stresses. Movement up slope was obtained by two 50-ton winches. (All photos are by Ontario Hydro.)

permit the passage of all mucking equipment. While mucking was in progress, an elevator at the rear of the jumbo lifted all material required for drilling the next round and for supporting the roof rock exposed by the previous shot.

Drilling equipment on each jumbo consisted of 19 Joy T-350 wet-type drifters. These are chain feed with an 8-ft carriage, enabling drill-steel changes to be made in 8-ft lengths. All were mounted on Joy hydrodrill jibs with power lift and swing, hydraulic pressure being supplied by a Joy unitized air-operated pumping system.

The headings, having a volume of 44 cu yd per lin ft (full section 76 cu yd), were drilled with $1^1/_4$-in. hollow round drill steel using Timken tungsten-carbide insert detachables, kept sharp by grinding. Some Liddecoat throw-away bits were used. All drill steel for each round is removed to the surface for complete check so that each drilling cycle loses a minimum of drill time. The holes varied in number from 140 to 182, and in depth from 16 to 24 ft. Although a set pattern was established (Fig. 3), leeway was allowed to balance the work at alternate headings and to allow for difficulties encountered in scaling the face and roof. The most workable round was one having 182 holes with a 7-hole burn cut in the center of the face. Rib holes 20 ft deep, with 22-ft relievers, pulled in excess of 18 ft. This round provided muck which was not too difficult to pass through bins and gates and made a muck pile of sufficient height to facilitate scaling of the roof rock.

Canadian Industries supplied Drift-tite in $1^1/_4$-in. × 8-in. sticks and also 1- to 15-millisecond delay exploders with wires 24 ft long; $2^3/_4$ lb of powder were used per cu yd of solid rock along with 0.4 of an exploder.

Blasted rock at the tunnel faces is loaded by electrified Northwest 80 D shovels into 11.4-cu yd rear-dump diesel-driven 87 FD Euclid trucks. Trucks utilized below ground on a permanent basis were equipped with exhaust scrubbers. The shovels are equipped with short booms and dipper sticks, and with $3^1/_2$-cu yd dippers. Muck is hauled to the grizzly-covered skip loading pocket below the shaft bottom, and dumped into a 750-cu yd guillotine-gated storage bin. This bin discharges into two 12-cu yd measuring bins holding a skip load each.

After being hoisted to the surface the skips dump into the 120-cu yd muck bin in the headframe tower previously described. The muck bin discharges into 16-cu yd Marion trailer dumps, pulled by F 8 Fords, which haul the muck one to two miles to designated disposal sites. With easy grades on good haul roads, this equipment proved extremely satisfactory.

In spite of the generally excellent roof formed by the Irondequoit limestone, the weak Reynalis dolomite and Neagha shale beds underneath it (Fig. 2) made continuous roof support necessary.

The support consists of steel-rib sets spaced 4 ft on centers, supported by wallplates with bearing 10 in. above the springing line, on 12 × 12-in. timber posts 4 ft long. The ribs are H-beams weighing 43.64 lb per ft, a European section of 7.87 in. The wallplates were made up of two 10-in. 35-lb I-beams. A complete rib assembly was fabricated in four pieces, and the wallplates in 16-ft lengths. The ribs were held on 4-ft centers by $^3/_4$-in. round tie-rods and 4 × 6-in. timber spreaders, 12 to the set. The sets were blocked with timber ranging from 2 × 6 in. to 8 × 6 in. Outside the sets the rock was supported by the same sizes of timber precut to a 5-ft length and placed as required, or by cribs where necessary.

Between the ribs, steel lagging fabricated in 4-ft lengths was attached with carriage bolts and clips. Originally 6-in. 7-lb channels, with 2 in. between them, were used for this purpose, but after some experimentation it was discovered that a 12-in. 10-gage. pressed plate, which had about half the weight per sq ft, was equally satisfactory. Supporting steel ranged from 1,350 to 1,750 lb per ft of tunnel, depending on the type of lagging used. The timber requirement, including posts, spreaders, blocking and rock support, averaged 225 fbm per ft of tunnel.

Headings were advanced on an alternating basis. The tunnel crew consisted of one drill, one muck, and one support crew per shift. Each completed its cycle of work in one heading and then moved to the opposite one. Since the support steel was placed during the drilling period, the support crew moved with the drill crew. Best progress on the heading totaled 531 ft in six three-shift days in March 1953, made by the above arrangement of crews alternating in two headings.

Bench Excavated Last

Bench excavation was started only after the upper or heading section had been completely holed through and the bottom thoroughly cleaned. The mucking equipment used was the same as for the upper section.

Instead of using the conventional wagon drill or horizontal drilling for the bench excavation, it was decided to use a jumbo arrangement. This rig is essentially a platform 10 × 50 ft, spanning the tunnel and riding on monorail carriages suspended from the support steel by clamps and turnbuckles. The drill mounting consists of a $3^1/_2$-in. pipe attached to the long edge. Movement and position are obtained by using tuggers for both pulling and snubbing. The elevation of the jumbo is fixed by attaching the hangers at a definite distance above the wall-plates.

With the jumbo set at correct line and grade, a drill is mounted for each hole to be drilled in any jumbo position, using the same drills previously used on the heading jumbo. Holes

for excavation required 17 drills, with 2 additional drills mounted on each side, and to the rear, to drill the two holes in which to place the 1½-in. dowel pins that were driven under each support post as the jumbo advanced (Fig. 4).

With the drill bar at a constant elevation, and the drills all remaining in the same transverse position, the same length of hole was drilled by any one drill at each setting of the jumbo. The contour of the circular bottom established the length of these vertical holes.

At the beginning of the bench excavation, continuous drilling was tried, but had to be abandoned because each shot disturbed the drill holes as much as 300 ft in advance. As a result, only the length of bench that could be blasted in a single shot (about 30 rows) was drilled. Experimentation also proved a 3 × 4-ft drill pattern, with staggered intermediate plug holes, to be the most satisfactory. The plug holes, 3 to 4 ft deep, were necessary to break the top rock, which was fairly hard and broke slabby. Explosives used amounted to 1.75 lb of Driftite and 0.3 exploder per cu yd.

An unusual feature of the heading and bench excavation was noted as the work progressed. An inward movement of ¾ in. was recorded at the wallplates as the heading advanced, and an additional ¾ in. as the bench excavation proceeded. Also, when the bottom was cleaned and made ready for the invert concrete, it was noted that movement had occurred in the curb concrete already poured, and that the foundation rock had a longitudinal crack of great length in many places, sometimes as long as several hundred feet. This movement indicated that the tunnel size was very nearly the maximum that could be driven economically in this rock structure.

Driving the Inclined Sections

Mentioned earlier in this article were the inclined sections of tunnel at the intake and outlet ends. These ends rise on a 30-deg vertical curve of 225-ft radius, joining at the inlet end with the submerged gathering tubes, and at the outlet end with the open canal. The upstream inclines are approximately 450 ft long, and the downstream inclines 170 ft.

While methods used in driving these inclines were broadly the same as those used on the flat sections for both heading and bench, several adaptations to existing equipment had to be made. Platforms on both the bench and heading jumbos were adjusted so that, when in working position, they would be horizontal, and each structure was strengthened to take the increased stresses.

Movement on the slope is obtained by using two 50-ton winches, each having cables, sheaves, and other features of sufficient strength to handle the load alone. The use of two winches is a safety precaution.

Before the top heading excavation was begun, a 7 × 7-ft drift was driven in the center, 200 ft in advance, with niches in the upper end. This drift was used as an anchorage for the cable sheaves.

Muck was scraped off the slope of the top heading with a Joy 125-hp slusher hoist, picked up at the bottom with a ¾-cu yd shovel, and loaded into trucks. Progress on the heading was a steady 30 ft weekly.

Bench excavation at the sloping ends of the tunnel was carried on in the same manner as on the level heading section with the exception of mucking, which followed the same procedure as on the slope heading. Because of the slope and the incompetent shales encountered, the amount of arch support required was much greater than in the level tunnel. The sets were placed on 18-in. centers in a vertical position. The wallplates were imbedded in a concrete buttress having 4 ft of horizontal bearing. The amount of timber and blocking was also increased, and care was taken to block so that sets would get a vertical load.

Only Top Heading Ventilated

One of the prime considerations in the construction of a successful tunnel is ventilation. The design was based on the assumption that a movement of 50 fpm in the tunnel heading was necessary to dissipate the Driftite fumes and particularly the diesel smoke from the haul units and tractors. The friction factor ($K \times 10^{10}$) used in the calculation was 25 for steel pipe. This factor is considerably higher than that given in all handbooks but the vent pipe in a tunnel is usually damaged somewhat in handling and corrodes quickly. Also, considerable rock dust is generally deposited in the pipe, increasing the resistance to air flow.

Making allowance for these conditions, the air requirement was found to be 60,000 cu ft per min at 31 in. on the water gage for a 48-in. line 3,400 ft long. Joy 48-26 ½-1750-x8377, Series 1,000, Axivane fans with 75-hp motors were selected for this service. These fans have a working pressure of 7½ in. of water, so four in series were required for a line 3,400 ft long. Fans were placed close together in series on the surface.

The ventilating pipe of 48-in. diameter was of 10-gage steel, with ¼ × 2-in. ribs on 2-ft centers, designed for a 6-psi pressure. The rib spacing was closer than necessary to care for the pressure, but the ribs assisted in hanging the pipe to the tunnel support steel. The pipe was hung along the side at the mid-point by steel banding on 8-ft centers. As an added precaution, a ½-in. cable attached to the steel was looped around the pipe every 100 ft. The location of the pipe was such that it did not interfere with the movement of the heading jumbo even when carried within 150 ft of the face. The pipe was fabricated in 20-ft lengths. Joints were made with the Naylor wedge lock coupling. Bench excavation requires no mechanical ventilation.

Compressed air for drilling and other uses comes from batteries of Joy size 13 × 8 × 7 WN102, 150-hp compressor units, each producing 720 cfm, 8 being set up at the top of each of the three shafts (Shafts 3, 4 and 5). These units have radiator cooling systems and a mounted compensator. They require practically no foundations and were erected at a very low cost. This arrangement permitted a shuffling of compressors to suit the air requirement of the work at each shaft.

Ground for shaft excavation was broken in July 1951. To date, as of September 15, top headings have been completely holed through, bench excavation is about half completed, and placing of concrete lining has begun.

The entire Niagara Falls power project as planned will cost about $343 million. The contract here described covers 60 percent of the tunnel length and is for about $60 million.

The Sir Adam Beck No. 2 power development is under the general direction of Robert H. Saunders, Chairman, and Dr. Richard L. Hearn, M. ASCE, General Manager and Chief Engineer, of the Hydro-Electric Power Commission of Ontario. On the site, Gordon Mitchell is Project Manager, with William L. Fraser, Project Engineer.

For the contractor—a joint venture composed of B. Perini & Sons, Inc., Walsh Construction Co., Arthur A. Johnson Corp., Henry J. Kaiser Co., C. A. Pitts General Contractor Ltd., Morrison-Knudsen of Canada Ltd., and Mannix Ltd.—the work is managed by Perini, under the direction of the writer as project manager, and Alex Simpson as general superintendent.

Special instruments measure WASHO road-test data

Engineers, industrialists, administrators, and others in the highway field are watching the WASHO road test now finishing its first year. In July 1953, the Highway Research Board, in immediate charge of constructing and operating the test, released the first news that expected failures had developed in the thin sections of pavement under the test trucks. Part 1 of the report, covering construction of the test pavement and other features, will be out this year. In due course, after the test runs are over, some time in 1954, a final report on the test will be published.

To safeguard against publication of premature conclusions drawn from ncomplete or distorted data, the committee in general charge of the operations has imposed a mild censorship. Visitors may watch the operations as they choose, but test data, which are being accumulated in great volume, are closely restricted. Even without access to these data, any engineer familiar with highway design who visits the project cannot but reach some conclusions from observation alone.

The amount and quality of the instrumentation used to cover the operations is outstanding. Whatever happens to the test sections or however it happens, there will be a wealth of actual measurements to support the conclusions presented in the final report. One expected conclusion, warranted by visual observation of the pavement condition, is that thin, underdesigned pavement, when subjected to a succession of heavy loads, fails first, and fast, along the wheel track next to the pavement shoulder. Signs of distress along the outer wheel track of some of the thinner test sections call sharp attention to this critical shoulder zone in any highway. This conclusion seems at present to be the most important visible result of the WASHO test. Some stretches of shoulder were "roofed," during July 1953, with hot-mix bituminous material 2 in. thick and 6 ft wide. At the same time the joint between the pavement and the shoulder surfacing was made as watertight as practicable. Trucks will continue to run on the pavement and keep off the shoulder. It is hoped by these means to determine the degree to which the drier shoulder will arrest the horizontal outward flow of subbase material from beneath the outer wheel track, a condition widely observed on highways throughout the nation. These developments in the WASHO road test show that more attention must be given to finding some practical way to keep highway shoulders dry to a considerable depth and to provide lateral support for base material at all times.

W. N. CAREY, JR., A.M. ASCE

Project Engineer, Highway Research Board

National Research Council, Washington, D.C.

Trucks running day after day on the WASHO road test, near Malad, Idaho, are developing information of great economic value to the nation. It is information which may go far in helping to resolve the basic question in U.S. highway construction—What are the maximum loads on which it is economically feasible to base the design and construction of our roads?

General acceptance of the conclusions which will follow completion of the test is likely to be proportionate to the quality of the test records obtained. Measured facts are strong arguments. This brief description is therefore presented to set forth the WASHO test layout and some details of the instrumentation provided to measure and record the facts as developed. Some of the instruments used to measure primary variables are described; many others are used to measure special phenomena from time to time.

The WASHO test is sponsored by the Western Association of State Highway Officials (WASHO). The Highway Research Board was selected to supervise the construction of the test road and the test itself. The project is designed to answer some of the problems facing highway administrators and the transportation industry. By pooling their support under the direction of this independent institution, which has no interest in the matter other than the development of facts and the acquisition of new knowledge, the state highway departments, U.S. Bureau of Public Roads, truck and trailer manufacturers and operators, petroleum industry and others, have demonstrated a sincere desire to acquire unbiased information on a problem of great mutual importance.

The Immediate Objective

The immediate objective of the test is to develop information concerning the relative effectiveness of several designs of flexible pavement varying in over-all thickness from 6 to 22 in., under repeated applications of 18,000 and 22,400-lb single-axle loads and 32,000 and 40,000-lb tandem-axle loads.

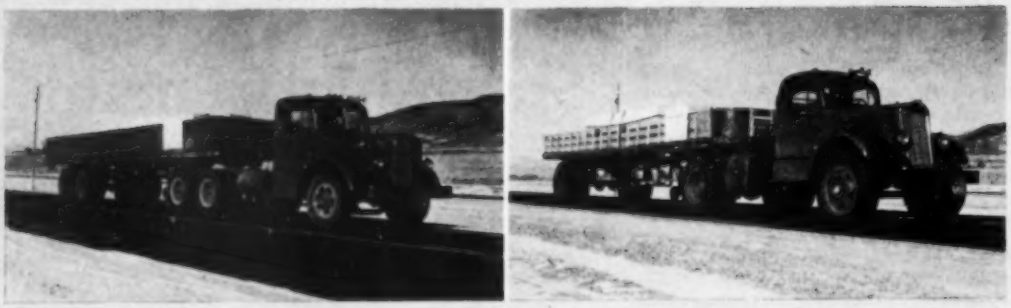
The test layout consists of two separate paved loops with tangents 1,900 ft long and 24 ft wide. The tangents in each loop are connected by superelevated turnarounds designed to permit the test trucks to operate at a constant speed in the neighborhood of 30 mph. The two loops are separated by a service area approximately 600 ft long in which are located such facilities as the field office, truck maintenance facilities, instrument storage, weighing equipment, and road maintenance stockpiles.

Throughout all phases of the construction, from clearing operations to final pavement finishing, the engineers directed their efforts toward securing uniformity of the components. Normal construction practices were simulated instead of attempting to obtain extra-high densities or superconstruction of any type. Construction of the test project was completed September 30, 1952.

Pavement Thickness Varied

The pavement in the tangents of the test loops was varied in thickness as shown in Fig. 1. On one tangent in each loop the top 6 in. is made up of 2 in. of asphaltic concrete over 4 in. of $^3/_4$-in. granular base material. In the other tangent of each test loop, the top 6 in. consists of 4 in. of asphaltic concrete over 2 in. of granular base material. Thus, all

FIG. 1. Schematic layouts of north and south loops show varying depths of asphaltic concrete surfacing (A.C.) and subbase courses. In air view of loops at



Test vehicles are tractor-semitrailers. That at far left (Type A) imposes total load of 32,000 lb on each set of tandem axles, and that at near left (Type B) exerts total load of 22,400 lb on each two rear axles.

four tangents have a 6-in. thickness of combined asphaltic concrete and base. Each of the four 1,900-ft tangents is divided into five 300-ft test sections with 100-ft transitions between them. The only difference between these sections is in the thickness of the subbase, which consists of pit-run granular material ranging in size from 2 in. downward. One section in each tangent has 16 in. of granular subbase material, the next 12 in., the next 8 in., the next 4 in., and the last zero (that is, it is laid directly on the subgrade soil). Thus the total thickness of pavement over the subgrade soil varies from 6 to 22 in. on each of the four test tangents. To reduce delays caused by pavement maintenance, the turnarounds are all 22 in. thick. Three special test sections, each 200 ft long, have been provided to study the behavior under heavy traffic of surface treatment, and of two thicknesses of road-mix bituminous surfacing.

For the purpose of the test, the 24-ft width of the tangents is considered as two separate 12-ft lanes. The outside lane is being tested under the heavier vehicles and the inside lane under the lighter vehicles. Since the two lanes were constructed at the same time, on identical soils and under identical conditions, it will be possible to compare directly the behavior of the outside lane with that of the inside lane. Differences in the behavior of one lane as compared with the adjacent lane can be attributed directly to differences in axle loads.

Test Vehicles and Loads

The test vehicles are tractor-semitrailers. On the north loop, single-axle combinations are used, with 18,000-lb axle loads running on the inside lane and 22,400-lb single loads running on the outside lane. On the south loop, tandem combinations are used, with 32,000-lb tandem-axle loads on the inside lane and 40,000-lb tandem-axle loads on the outside lane. Two vehicles operate in each lane; thus the test requires eight tractor-trailer combinations.

Traffic operation is scheduled on the basis of two 9-hour 10-min shifts per day, six days a week. Each shift consists of nine 50-min driving periods, seven 10-min rest periods, and one 30-min meal period. Thus, barring truck breakdowns, the test vehicles operate 15 hours per day.

The drivers are able to maintain an average speed around the entire loop of slightly less than 30 mph, and since this distance is 6,600 ft ($1^1/_4$ mile), a round trip takes about 2.75 min. Since there are two combination vehicles in each lane, the pavement is subjected to two heavy-truck loads every 2.75 min. At this rate each section undergoes about 650 truck-trailer applications per day, or 17,000 per month. Although it is planned to keep all trucks in the best possible condition, it is not likely that this theoretical rate of application can be maintained during the entire test period.

Accurate Instrumentation Provided

The construction and the trucks provide test sections with built-in variables known in advance, and with control over the size, frequency of application, and transverse position of the test loads. All that remains is to evaluate the relative effects of the various test loads on the different pavement sections. Because of the extreme susceptibility of the paving materials, and particularly of the subgrade soils, to variations in moisture content and temperature, a good deal of attention was given to measuring these phenomena. Complete routine weather records are kept at the site.

Of far greater importance than these routine records are the temperature and the moisture content of the pavement components as influenced by the weather. To simplify the problem of obtaining information of this type, thermisters and moisture cells were placed during construction in certain test sections at various depths down to 72 in. The thermisters consist of simple metalic oxide disks, the electrical resistance of which varies markedly as their temperature changes.

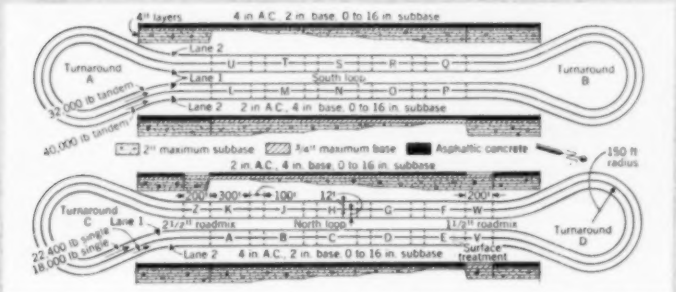
The temperature of the thermister, and thus of the material surrounding it, can be obtained at any time by reading its resistance as measured with a simple a-c ohmeter across the leads at a terminal board located at the side of the road. The portable ohmeter rests conveniently on top of the terminal board, and its leads are clipped to the leads of the thermister being read. Two men with an automobile can read all thermisters and moisture cells in the project in half an hour.

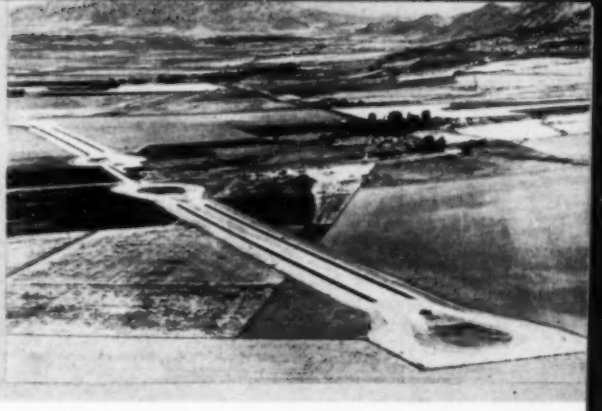
Buried beside the thermisters throughout the project are moisture cells. These are also of the electrical resistance type, consisting of a sandwich of two electrodes separated by fiberglas (or nylon). The resistance between the electrodes changes as the moisture content of the filler changes. The moisture cells are read in the same manner as the thermisters, using the a-c ohmeter. However, they are not as direct or simple to use. The calibration process is extremely important and rather complicated. It is also tedious, requiring about a month for each soil, but reliable results cannot be expected by any other means advanced to date.

The method of installing the cell in the soil is also important if reliable results are desired in a reasonably short time. The moisture cells used on the WASHO test came to equilibrium within about two months. Given proper calibration and installation, it is only necessary to read the resistance, make a correction for temperature (taken at a nearby thermister), and read the moisture content from the calibration curve corresponding to the density of the soil in place.

In addition to the routine checks of moisture content taken by means of the moisture cells, detailed studies of moisture content in the base and subgrades are made whenever any part of the pavement surface is opened for any reason, and of course wherever pavement failures occur.

FIG. 1. Schematic layouts of north and south loops show varying depths of asphaltic concrete surfacing (A.C.) and subbase courses. In air view of loops at right, south loop is in foreground.





One of the first indications of structural distress in a flexible pavement is the appearance of longitudinal rutting in the wheel tracks. This is often of small magnitude and hardly noticeable to the naked eye, yet for it to occur, something in the pavement structure has to give, and if the rutting progresses, serious damage will eventually develop. Furthermore, longitudinal rutting may be due to shifting or consolidation of the subgrade, subbase or base, or to shoving or compression of the wearing surface. Recognizing this, means were sought to detect such deformations early and to relate them to a definite part of the pavement structure.

It soon became apparent that, as a first step, innumerable transverse surface profiles had to be taken. This was accomplished by a special profilometer, designed and built by the engineers and mechanics of the Bureau of Public Roads. This profilometer is a double truss which spans the entire pavement. It is supported at the ends by pins driven 7 ft into the shoulder, and steadied at the center by an adjustable third leg which rests on the pavement. Its bottom chords follow the pavement crown about a foot above the surface.

A motor-driven carriage hangs by three wheels from the truss chords (see an accompanying photograph) and, in operation, moves across the pavement in about 30 sec. Suspended from the carriage by a pantograph linkage is a small steel wheel which rides on the pavement surface and, as the carriage moves along the truss, follows the transverse profile of the pavement surface. The vertical movement of the wheel is measured and recorded electronically by means of a linear variable-differential transformer (LVDT) and an oscillograph. Since the profilometer support pins do not change elevation, the truss acts as a reference plane throughout the test, and any difference between the oscillograph trace taken before the test and that taken during or after traffic operations, represents a change in the surface profile.

Profiles can be taken wherever support pins are provided. For the WASHO test, five sets per 300-ft test section were provided, one set every 60 ft. The entire operation, including the taking of the profile, moving to the next location, and setting up the equipment to take the next profile, requires about 3 min for a three-man crew.

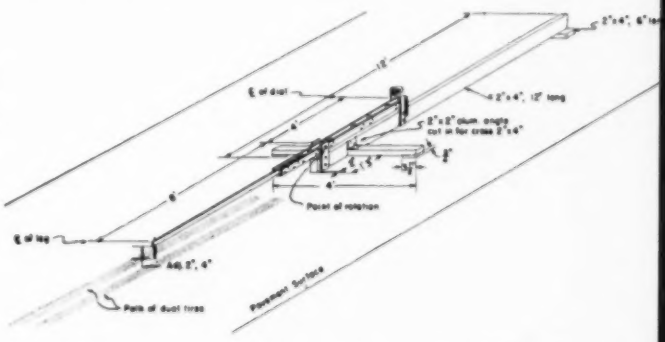
To determine where the deformations occur—that is, whether in the subgrade, subbase, or surface—an auxiliary system was devised, made up of devices called settlement assemblies. A settlement assembly consists of a perforated steel plate about 5 in. square; a rod about $1\frac{1}{2}$ in. shorter than the thickness of the pavement structure, with a self-tapping screw welded to one end; a riser rod; and miscellaneous collars, etc. The perforated plate is placed during construction on the surface of the subgrade (or subbase).

After construction is completed, a $\frac{1}{2}$-in. hole is made through the pavement to the plate, and the rod is screwed into one of the holes in the plate. The hole around the rod is then filled with sand to within a few inches of the surface, and a short steel tube of $\frac{1}{2}$-in. diameter is inserted to prevent the top of the hole from collapsing. A rubber stopper is pressed into the steel tube when the installation is not in use. When readings are to be made, the cork is removed and a riser rod inserted. Readings are taken by rolling the profilometer wheel over the top of the riser rod. The high point of the oscillograph tape is then an indication of the elevation of the subgrade (or subbase) with respect to the profilometer truss.

Some of the early work on the Board's flexible-pavement research project in cooperation with the Asphalt Institute and the Bureau of Public Roads, carried out at Hybla Valley, Va., and elsewhere, indicated that the elastic deflection under load of a flexible pavement structure, or of its subgrade, is of significance, and that information about it may be useful in predicting pavement failures. In the WASHO test, it was decided to measure elastic deflections both within

(*Continued on page 97*)

FIG. 2. Benkelman lever-arm deflection indicator is designed to measure pavement deflection at critical point, from a truck load at creep speed. Instrument is positioned on pavement and straddled by dual wheels.



Profilometer is in form of double truss supported at ends on pins driven into shoulder. Motor-driven carriage (right), suspended from truss, runs across pavement surface, following transverse profile. Vertical movement is measured and recorded electronically by linear variable-differential transformer and oscillograph.

Most of compacted earth lining on Friant-Kern Canal was placed by carryalls. In view at right, tandem sheepsfoot roller is making final pass on one layer before deposition of next layer by carryalls. Extensive program of sampling and testing was conducted throughout construction period for control of borrow, embankment, and lining. Completed earth lining appears at far right.

Low-cost compacted earth lining shows

To secure economy of construction as well as low seepage losses, the U.S. Bureau of Reclamation has tried various types of canal linings, among them compacted earth. This type of lining, because of its low cost, has been given special consideration. In 1950 a comprehensive testing program was carried out on the Friant-Kern Canal, on which earth-lined reaches totaling 22 miles in length had been in operation almost two years. This article also describes the construction methods used on the reaches lined with compacted earth, and the laboratory and field testing program followed during the construction period.

That part of the Friant-Kern Canal pertinent to this discussion lies on the east side of the San Joaquin Valley, adjacent to the foothills of the Sierra Nevada (Figs. 1 and 2). It crosses several embayments or coves in which are ancient or existing drainage courses. Between these embayments granitic hills jut out into the valley. Surface soils are predominantly reddish-brown clay loam to sandy clay loam, underlain by a layer of hardpan at depths ranging from 2 to 6 ft. Materials in and adjacent to the stream courses are sand or sandy loam. In the sloping ground of the interstream areas along the base of the hills, expansive clay-type soils are found. Soil strata are very discontinuous, especially in embayments between hills.

An intensive study of soils along the proposed canal line was commenced in 1945. Forty-one test pits were excavated by hand, and 120 holes of 24-in. diameter were put down with a rotary drill. Logs of the holes were made by the geologist, who studied the size, shape and grading of particles, their degree of compaction or cementation and other pertinent features. On the basis of this examination an estimate was made of the probable permeability of the natural soil, as well as of its suitability as an embankment material. Each stratum in the test pits was sampled for testing in the field laboratory. Mechanical analysis, specific gravity, percolation and compaction tests were made on these samples. Samples from the drill holes were examined in the laboratory and compared with samples from the test pits. Laboratory tests were made on a few of these as a check.

The sample container developed for obtaining undisturbed earth samples is shown in Fig. 3. In the field, the metal sleeve was slipped down over a desired specimen as the surrounding earth was removed. Sealing the specimen was then accomplished and the assembly taken to the laboratory, where the specimen was removed and cut down to the

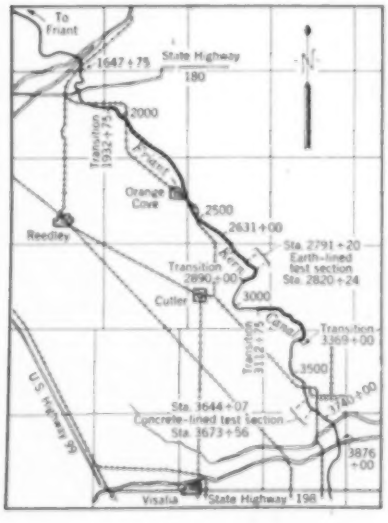
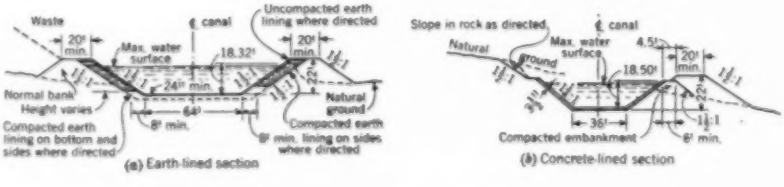


FIG. 1. Friant-Kern Canal, part of Bureau of Reclamation's Central Valley Project in California, extends from Friant Dam on San Joaquin River to Kern River near Bakersfield, total distance of 160 miles. Earth-lined reaches of canal total 22 miles, between Stas. 1932 + 75 and 2890 + 00, and between Stas. 3112 + 75 and 3369 + 00, where soil and location features favored this type of construction.

FIG. 2. Friant-Kern Canal cross sections differed considerably in dimensions for earth and concrete linings.



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low seepage losses on Friant-Kern Canal

desired size, after which it was coated with paraffin for inundation determination of specific gravity or storage prior to determination of the percolation rate. Percolation rates of recompacted samples were obtained in the usual manner, except that the load was 1 lb per sq in. This light loading was applied in view of the small embankment height required for the canal.

Field permeability tests were made by means of open-pipe or standpipe permeameters (Fig. 4), hereafter called Friant permeameters. The procedure was to excavate a hole about 18 in. in diameter and 18 in. deep. A length of 10-in. well casing was set in the hole and selected backfill tamped around the lower end of the pipe to a depth of 18 in. The pipe was filled with water, and a can inverted on the pipe as a constant-head tank. Twenty field permeability determinations were made in the test pits. A factor f was computed, it being the loss of water in cubic feet per second per square foot of permeameter area under a head of 1 ft, times 10^5.

Studies were carried on throughout the construction period. These were in addition to the control tests, and consisted principally of permeability and percolation tests as well as studies of areas proposed as sources of borrow material for the lining. There were 281 hand-dug undisturbed samples taken, 100 from the natural ground and 181 from the compacted earth lining. Percolation rates were determined on 100 remolded samples from natural ground and on 90 samples from the compacted earth lining. Field permeability rates were determined at 175 locations in natural ground and 213 locations in the compacted earth lining.

Control of embankment construction depended to a large extent on the results of laboratory tests. Penetration resistance and field density tests were the most important, although permeability and percolation tests contributed much to the knowledge of embankment quality.

Efficiency of compaction was determined by the field density test. Efficiency is defined as 100 times the quotient of embankment density divided by maximum density of optimum moisture content in the laboratory. Specifications required a minimum efficiency of 98 percent. Penetration resistance readings were taken regularly by laboratory technicians for the information of the inspectors. The average efficiency of 733 density tests in the compacted earth lining

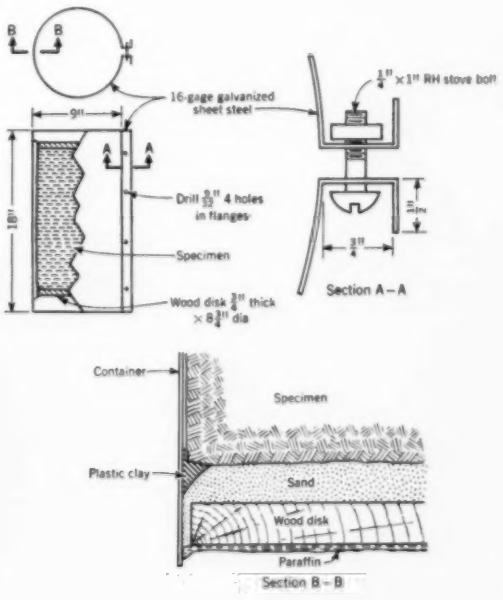

FIG. 3. Container for "undisturbed" earth samples consists of sheet steel sleeve which is slipped down over specimen as surrounding earth is removed. Steps in preparation of sample are illustrated in photo below, in which "A" is sheet-metal container, "B" soil specimen ready for cutting to proper size, and "C" specimen trimmed and coated with paraffin.

TABLE I. Permeability data summarized

	Field Permeability, f		Ratio	Percolation Rate k				Ratios of k				$c = k/f$	
				Undisturbed		At Lab. Density		k (Undisturbed) / k Lab. Dens.		k (Nat. Ground) / k (Earth Lining)			
	Nat. Ground	Earth Lin.	f(NG) / f(EL)	Nat. Ground	Earth Lin.	Nat. Ground	Earth Lin.	Nat. Ground	Earth Lin.	Undis.	Lab. Dens.	Nat. Ground	Earth Lin.
(a) Sta. 1932+75 to Sta. 2890+00													
No. of tests	144	184	124	82	152	82	66	78	66	71	35	71	139
Maximum	55.00	8.37	1121.50	542.00	27.00	300.00	1.47	17200	2600	560	1511	1517.64	195.00
Minimum	0.01	0.007	0.01	0.07	0.03	0.003	0.001	0.6	0.05	0.03	0.01	0.20	0.03
Average	4.04	0.77	50.53	48.71	1.78	5.75	0.146	909.2	128.2	45.9	78.4	56.09	15.07
(b) Sta. 3112+75 to Sta. 3369+00													
No. of tests	31	29	26	18	29	18	24	17	26	18	17	18	25
Maximum	34.28	3.49	2872	1185.0	9.80	128.3	0.35	13794	1300	5520	14255	270.1	1960
Minimum	0.96	0.005	0.91	0.12	0.10	0.02	0.001	0.02	0.95	0.10	0.05	0.08	0.4
Average	6.41	0.54	207.5	168.24	1.59	8.03	0.08	1622.3	107.6	381.1	859.2	38.1	101.5

was 101.1 percent, and for 44 tests in the rolled bottom it was 99.7 percent.

For the purpose of obtaining as much information as possible concerning the earth lining, the program of sampling and testing included determination of the following:

1. Natural-in-place density
2. Laboratory maximum density
3. Earth-lining density (in place)
4. Field permeability factor f for natural-in-place soil
5. f for compacted earth lining
6. Laboratory percolation rate k for undisturbed samples of natural, in-place soil
7. k for undisturbed samples of compacted earth lining
8. k for remolded samples from both natural ground and compacted lining

From the above tests, together with sieve analyses and other tests, it was possible to obtain a comparison of the compacted earth lining with the natural ground and with laboratory conditions. However, it should be pointed out that, strictly speaking, there probably is no means of obtaining a truly "undisturbed" soil sample. The mere act of removing the sample constitutes disturbance, to say nothing of the relief of stresses resulting when the superimposed earth load is removed in getting at the sample. Be that as it may, comparisons were made, and a summary of the tests is given in Table I.

Construction of the earth-lined parts of the canal was done under two schedules by two separate contractors. Excavation of the canal prism was generally accomplished by draglines, but carryall scrapers and a special elevating grader were used on small parts of the work.

Most of the compacted earth lining was placed by carryalls. As the specified horizontal thickness of the lining was 8 ft, it could be constructed in the same manner as a dam or rolled earth embankment. In those locations where excavation was done by the dragline, the earth material was moistened in the spoil bank when required, then picked up by the carryalls for distribution over a reach of the canal to be lined. Compaction was effected with sheepsfoot rollers except in the immediate vicinity of structures, where manually controlled tampers were employed. The rollers were usually in tandem behind track-laying tractors. The actual horizontal thickness of the lining was the minimum possible to permit operation of the equipment (about 11 ft). After the embankment had been placed, excess material was removed by dragline.

In those locations where carryalls were used for excavation of the canal section, stripping of unsuitable surface materials was usually done by dragline. The carryalls then removed the compaction material and deposited it in layers for the lining of adjoining sections. Earth from borrow areas was usually excavated and hauled by carryalls. Thus the material being compacted may have come from any one or from several locations, such as: from adjacent spoil banks, if the original excavation was by dragline; from the central part of the adjacent prism; from overexcavation for lining on the opposite side of the excavation; from overexcavation for lining ahead of or behind the reach being lined; and from borrow pits.

Two procedures were followed in treating the canal bottom. In areas of permeable soils the bottom was overexcavated 2 ft and selected, impermeable backfill placed. By far the largest part of the bed of the canal, however, was processed by what was called "bottom rolling." This process consisted of scarifying the canal bottom to a depth of 1 ft,

FIG. 4. Open-pipe or standpipe permeameter, referred to as Friant permeameter, has varying dimensions depending on expected permeability.

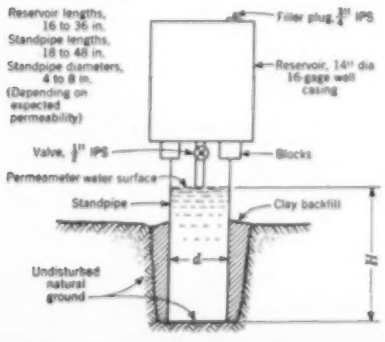

TABLE II. Total seepage from test sections, cubic feet per day based on final readings

Test Method	R	R/R_h	S	S/S_h	Remarks
Undisturbed samples	0.00354	0.600	13,104	0.600	Weighted to area
Seepage meters	0.00412	0.698	15,252	0.698	Average all meters
Hook gage	0.00590	....	21,841	....	Final actual rate of loss
Undisturbed samples taken during construc.	0.007	1.186	25,900	1.186	Average of 7 samples
Friant permeameters	0.014	2.373	51,826	2.373	Average all meters
Well permeameters	0.0404	6.847	149,556	6.847	Average all wells
Friant permeameters	0.2545	43.14	942,127	43.14	Average all meters unwatered canal
Friant permeameters taken during construc.	0.633	107.3	2,342,000	107.2	Average of 7 tests
Hook gage, concrete	0.0054	0.915	13,488	0.6176	Final actual rate of loss

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wetting the scarified material when required for proper compaction, rolling with a sheepsfoot, and finally rolling with a pneumatic roller or loaded carryall.

Paving of the concrete-lined portions of the canal was accomplished with a traveling slip-form. Immediately following the slip-form, grooves 1 in. deep by $^1/_4$ in. wide were formed in the fresh concrete at a spacing of about 12 ft, longitudinally and transversely. These grooves were subsequently filled with a cold applied, internal set-up, asphaltic filler. For curing, a white-pigmented sealing compound was sprayed on the fresh concrete as soon as the grooves had been filled. None of the lining was reinforced except at transitions and adjacent to some structures.

Two test sections were prepared—one earth lined and one concrete lined (Fig. 2). The sites for these sections (Fig. 1) were chosen because: (1) the depth to ground-water table was relatively deep, (2) a nearly straight reach of canal was available, (3) soil conditions were fairly uniform, and (4) an abundant supply of earth for the dikes was nearby. In addition, the earth section, except for 500 ft of the bottom, was lined with select material. (The 500-ft unlined portion of the bottom was scarified and rolled.)

The earth-lined test section was the first to be prepared. Wells, cased with 1-in. perforated pipe, were drilled to a depth of 60 ft to observe the ground-water level in the immediate vicinity. These wells were located on the canal berm and in nearby fields. Construction of the dikes was started on September 5, 1950, using material trucked from spoil banks along the canal and along a nearby drainage ditch. The main dike was constructed to the elevation of the berm of the canal. A smaller, auxiliary dike was built immediately upstream from the upper main dike to prevent water in the canal outside the test section from coming in contact with the main dike. In this way it was possible to make sure that there was no leakage through the dike.

As at the earth test section, the first work to be done on the concrete-lined test section was the drilling of test wells to observe the ground-water table. These holes were between 90 and 100 ft deep. As soon as the construction equipment was no longer required at the earth section, it was moved to the concrete section for construction of the dikes at that location. These were completed on September 26.

To observe the drop in elevation of the water surface, two hook gages were installed in each pond, one at each end (a total of four gages). These were attached to posts driven into the canal bottom at the ends of wharves built out into the canal. Evaporation pans were attached to rafts and one placed on each pond. A maximum-and-minimum thermometer, for registering air temperatures, was placed in a suitable location adjacent to each test. Instruments used at the concrete test section were two hook gages, one evaporation pan, and a maximum-and-minimum thermometer.

For the earth-lined pond, ten Friant permeameters were installed. These permeameters were of the same type used so extensively during construction of the canal. Instead of operating at low heads, however, they were constructed to operate under heads approximating the water depth in the pond where they were located. Four of them were in the canal bottom and six on the sides. In installing them, care was taken to place the ends of the vertical pipes uniformly 5 in. below the ground surface of the canal bottom. They were set deeper on the canal sides.

Thirteen seepage meters were set into the canal bottom after a 1-ft depth of water had been pumped in. A sheet-steel cylinder with a cross-sectional area of 2 sq ft was pressed into the earth until it was firmly seated (about 4 or 5 in.). A flexible plastic bag, connected to the small tube on top of the seepage cup, was submerged in the water of the canal and furnished water to the isolated area under the cup. Equality of pressure inside and outside of the cup was assured when the plastic bag was submerged. This meter is a modification of the constant-head permeameter developed by the Department of Agriculture.

The well permeameter was another type used. This instrument was installed by first augering a 4-in. hole to the required depth, usually about 28 in., determining the volume of the hole by means of density sand, backfilling the hole with permeable sand, and finally installing a protective screen casing. These instruments were designed to operate under a constant head, and measure the flow out of the sides of the test hole as well as the bottom. After all field tests had been completed and the water drained from the canal, the Friant permeameters were operated under low heads.

Thirty-three undisturbed samples were taken from the sites of 10 Friant permeameters, 13 seepage meters and 10 well permeameters on completion of all other work, and their percolation rates determined under a load of 1 psi. It is interesting to note that the final weighted average value of seepage from these tests was considerably smaller than that measured by the hook gages (Table II). A mechanical analysis was made of the soil from each undisturbed sample, together with a determination of undisturbed density and laboratory maximum density.

One conclusion that stands out is that the seepage from both test sec-

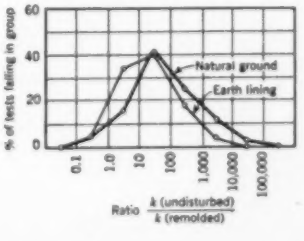
(*Continued on page 98*)

TABLE III. Some cost comparisons between compacted earth and unreinforced concrete canal linings*

	Av. Capacity, cfs	Total Length	Av. Lining Thickness	Av. Cost per Sq Yd of Lining	Date Installd
Friant-Kern Canal:					
Unreinforced concrete	5,000 to 2,500	122 miles	3½ in.	2.20	1947–51
Heavy compacted earth	5,000	25 miles	2 ft bottom, 3 ft slope	0.46	1947–48
Delta-Mendota Canal:					
Unreinforced concrete	4,600 to 3,310	99 miles	4 in.	2.42	1949–51
Heavy compacted earth	3,310 to 3,211	18 miles	2 ft bottom, 3 ft slope	0.42	1947–51
Wellton-Mohawk Canal:					
Unreinforced concrete	1,200	10.1 miles	3½ in.	2.53	1950
Heavy compacted earth	1,300	6.45 miles	2 ft	1.31	1949

* Installed by Bureau of Reclamation by contract. Data taken from *Canal Linings and Methods of Reducing Costs*, U.S. Department of the Interior, Bureau of Reclamation, U.S. Government Printing Office, Washington 25, D.C.

FIG. 5. Plotting of frequency distribution of k ratios for earth lining and for natural ground indicates that earth lining approaches condition of laboratory samples more closely than does natural ground. Logarithmic scale is used for cell boundaries because of great spread in values.



Cuts stabilized on Lookout

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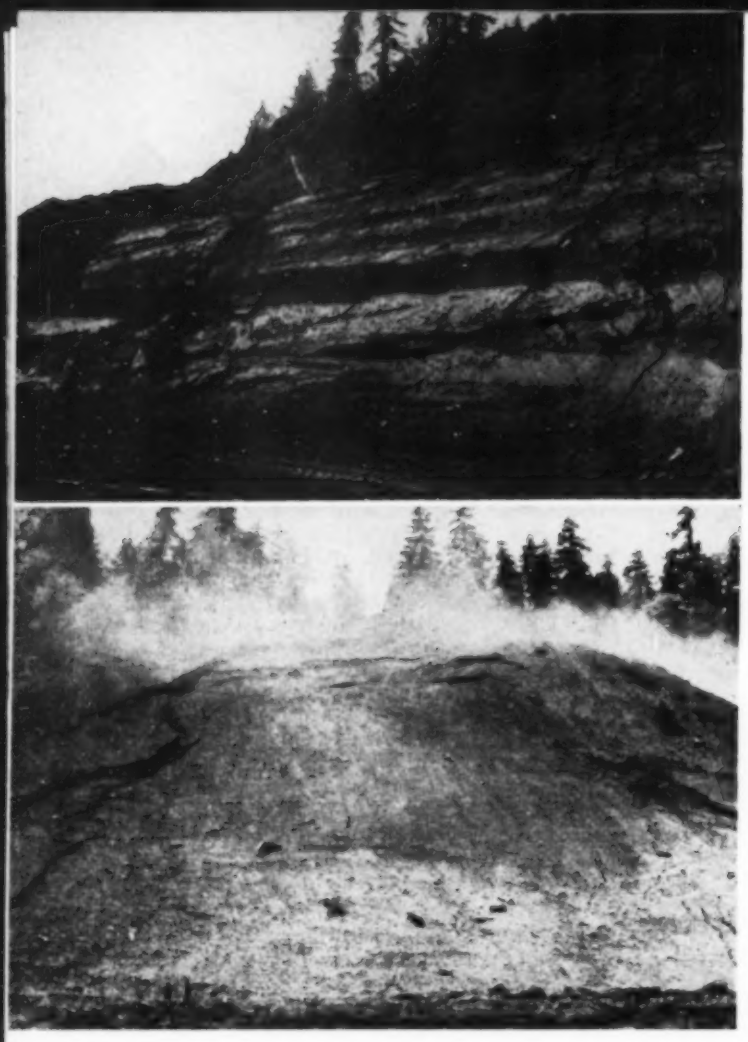


Slides—bane of the engineer on deep cuts—are here caught by camera's eye in progress on relocation of 23 miles of railroad and 14 miles of highway for Lookout Point Reservoir, Oregon. View at top shows typical stratified landslide material in one of the larger unstable cuts with a maximum height of 160 ft and extending along 1,000 ft of road. In many locations even a slope of 1 on 4 would not have been stable. Therefore horizontal drains were tried and proved highly effective in controlling slides.

Effects of water on the stability of soils are known, but economical methods of reducing these effects are among the greatest problems of soil mechanics. The horizontal-drain method here described, is not the answer to all slide problems but should be considered in many problems involving slope stabilization, particularly where there is seepage or a high water table. This method was found to be highly effective in stabilizing slopes on the railroad and highway relocation work for the Lookout Point Reservoir Project on the Middle Fork of the Willamette River, about 24 miles upstream from Eugene, Oreg. This project includes relocation of about 23 miles of Southern Pacific Railroad and 14 miles of Oregon State Highway No. 58 adjacent to the railroad.

On this project a large number of slides developed in cuts, requiring many different methods of stabilization, among them the drilling of horizontal drains, first used by the California Division of Highways in 1939. Cuts varied from 20 to 200 ft high and extended from 20 to 2,000 ft in length. The average large slide area was about 160 ft high and 1,000 ft long.

The relocated railroad and highway traverse fairly rugged, northward sloping terrain composed of volcanic materials deposited by lava flows and landslides. The landslides occurred in sequence, forming stratified masses of soil with seams of very highly plastic to non-plastic soil in regular and irregular layers. Some seams are water bearing, causing seepage, sometimes in the top weathered zone of bedrock, but more often at various distances above bedrock. These soil conditions, along with a mild climate and an average rainfall of 40 in. a year, were the main causes of slides on this project.

To define the trend of the weak seams and seepage points for the initial design would have required a very thorough exploration program. It was considered economical to analyze for stability based only on the lower strength values obtained from undisturbed samples of representative material and, where applicable, to consider the excess hydrostatic pressures. Of course, by this system some slides were anticipated. During construction, when the seams were encountered and the trend defined, further explorations were made along with a more thorough design analysis, and the cut slopes were reconstructed to the new design.

In a number of locations the new design analysis indicated that even a slope of 1 on 4 would not be stable. Not only would it be uneconomical to excavate the large quantities of material to such a flat slope, but the removal of these materials from the toe of the old landslides would in all probability start large mass movements. Therefore other methods of stabilizing the cut slopes were required. In some instances small slide areas were stabilized by remov-

by drilling horizontal drains

Point Reservoir relocation work

ing some of the slide material at the toe and backfilling with free-draining gravel or rock. This was economical for small areas where actual movement had taken place, thereby reducing the strength to such a low point that no other method would work. For large mass movements, deep temporary drain wells were installed, which stopped the movement until a more permanent drainage system could be developed.

These methods were satisfactory for all types of slides as far as stability was concerned, but a more economical means of stabilization was needed in all cases. It was decided to try horizontal drains.

Drilling Presents Problems

Most of the soils on this project contain a very hard basaltic talus rock, and the problem was to obtain a machine and a bit that would drill horizontally in this type of material.

A power auger drill used by the Oregon State Highway Department was tried initially. In this machine the auger is driven by a four-cylinder gasoline motor mounted on a ratchet assembly on rubber-tired wheels. The auger is in 5-ft sections and drills a 6-in.-dia hole without the aid of water. This drill has many advantages, among them ease of operation, ease of moving, speed of drilling, no need for water pump or pipe, and economy in both drilling and casing. However it would not drill in talus rock or rock, and therefore its use was restricted on this project.

Next it was decided to try a machine known as the "Hydrauger," used by the California Highway Department for drilling horizontal holes. This machine comes equipped with hollow drill rods and a pilot bit. It is powered by a 5.2-hp hollow-shaft air motor, requiring an air compressor and air lines. The motor is mounted on a ratchet assembly and the rods are fed in 5-ft lengths by a manually operated handle. A jet of water is piped through the hollow shaft in the motor and through the hollow rods to wash cuttings out of the hole and cool the bit. This requires a water pump and line.

The Hydrauger is a light-weight machine, easy to set up and move. Its main disadvantage is that the casing has to be installed either by hand or by a power winch and pulley. In some locations it is very difficult to get a power winch to the site. Another disadvantage is the need for an air compressor.

During our drilling with this machine a number of improvements were made. The water feed through the motor was eliminated by remounting the motor and using a chain drive so that the water could be fed directly into the drill rods, eliminating all possibility of water leakage into the motor. In remounting the motor, the mounts were constructed to accommodate a gasoline, electric, or air-driven motor. Even though the 5.2-hp air motor has proved adequate in most cases, the use of a gasoline or electric motor eliminates the need for an air compressor and lines. Because of the long hard drilling, the Hydrauger rods were replaced by heavier rods known as Diamond Drill A-rods, and for the most difficult drilling conditions by N-rods. Because of vibration in the manually operated handle, it was replaced by a manually operated winch and chain pull.

As several slides were threatening at the same time, additional equipment was required. A Sullivan core-drill machine, Model 12-B, with an M-2 Sullivan hydraulic head, was adapted for use as a horizontal drill. This machine is powered by a four-cylinder gasoline engine with a permanent power winch attached. It is mounted on runners and can be moved under its own power by using the winch. It has a high-powered, low-speed gear. The chuck in the hydraulic head can be changed very easily to take either A-rods or N-rods. Its biggest advantage is that the casing can be installed with power by inserting the casing into the hydraulic head in the same way the drill rods are inserted. This also enables the casing to be turned at a very slow speed while being installed. Other advantages are that the rods are fed by power and can be pulled by power, and different vertical angles can be easily set. Some of the main disadvantages are that it is harder to move, and the distance between the drive head and the beginning of the hole may be great, causing a whipping action in the rods. To drill effec-

Small slide areas were often stabilized by backfilling with free-draining gravel or rock at toe.

Some difficulty was experienced at first in drilling long horizontal drains through mixed material which included very hard basaltic rock and talus. Two drilling machines were used satisfactorily on this work—Hydrauger (above) and Sullivan core-drill machine (below).

tively with the Sullivan-type rig, there must be high-powered, slow-speed gears and a long hydraulic drive head. The cuttings are washed out and the bit is kept cool by piping a jet of water through the drill rods.

Water for drilling, usually obtainable near the site, was provided by a pump. The amount required varied with the type of materials to be drilled and the steepness of the vertical angle. If only a small quantity was available, a sump was excavated and the water recirculated. When water was not available near the site, it was hauled in a tank, pumped to the bit, and recirculated.

Various Drill Bits Tried

Various types of bits can be used with the Hydrauger or the Sullivan core drill. It was found that the pilot bit, furnished with the Hydrauger, would push the talus rock aside in a loose, disturbed state. The rock would be washed free, falling into the hole and wedging the rods. A fish-tail type bit and a Blue Demon rock bit were then tried without improvement. Believing the failure due to inexperience of the operator in drilling horizontal holes, an experienced man was obtained, with the same results.

After further investigation, it was realized that the principle of washed drilling is similar in many ways to rotary oil-well drilling, and a rotary rock bit was tried. Both the $4^1/_4$-in. tricone hard abrasive rotary rock bit made by the Hughes Tool Co. of Houston, Tex., and the $3^3/_4$-in. regular rotary rock bit made by the H. C. Smith Oil Tool Co. of Compton, Calif., have proved very successful in all types of materials, including clay, clay and talus, and solid rock. It is believed that the Hughes bit has some advantages in very plastic clays and the Smith bit in solid rock. Either can be used during the entire process of drilling, no matter what materials are encountered. Rotary rock bits are improved by welding wings, or ribs, on the shank. These ribs help to keep the hole straight and aid in removing the bit from the hole. The drill rod is also reinforced at the shank of the bit, as this point has proved weak.

Metal Casing Used

For casing holes, both galvanized and dip-black metal pipe, with $^3/_8$-in. perforations on $^3/_4$ points and 6 holes per ft, was used. Pipe diameter varied from $1^1/_2$ to $2^1/_2$ in., depending on the pipe available. The $1^1/_2$-in. pipe was preferred because of ease of placing and lower cost. Although only metal pipe was used on this project, it is believed that a plastic type would be easier to place, easier to perforate, less expensive, and more resistant to deterioration.

In some cases where caving was noted in seams of soft material, a special bit was constructed by welding teeth on the end of the casing, and using the casing as a drill rod. This can be done only when the core-drill type of machine is used. After the hole has been cased in this manner, the drill rods can be inserted inside the casing using a jet of water to wash out cuttings. The California Division of Highways has used a folding-type bit for this type of drilling and casing, but this bit has not been used on the project here described.

In all but two cases, the drains were cased without too much difficulty if the pipe was placed immediately after the drill rods and bit were pulled. In one of these two cases the material was small diced rock containing insufficient clay to prevent serious caving, and in the other, the material was coarse river gravel. In both cases difficulty in retracting the bit and in casing was experienced. Grouting of the diced rock was tried without success.

Effective Life of Drains

One of the questions which at present remains unanswered is the length of time drains of this type will be effective. The writer believes the hole will remain open as long as the casing lasts, depending on the chemicals in the soil. Once seepage has developed and the water is running clear, the flow will keep the casing clean. However, if the casing should become blocked, it would be very easy to clean with a jet of water. The possibility of roots plugging the casing is eliminated by not perforating the last 20 ft of casing installed. It is further believed that, if the hole remains open over a long period of time, consolidation of the material will be sufficient in most cases to increase the strength to a point where the slopes will remain stable.

Some Totals for Project

Over 28,000 lin ft of horizontal drains were installed on this project. The spacing, horizontal angles, and vertical angles of drains varied at each location, depending on seepage and water-table location. Drains were usually drilled until fresh bedrock was encountered. Exceptions to this rule were made where large flows of water were encountered and further drilling was considered unnecessary, or where a ledge of bedrock had to be penetrated to drain an upper layer of soil.

The maximum depth of any one drain was 350 lin ft, but greater depths could be obtained if necessary. The quantity of water from each drain, measured shortly after completion, varied from zero to as much as 140 gal per min. Where a drain was dry or there was only a small seepage at the beginning, very often the flow gradually increased and continued to increase as seepage found its way to the outlet. In other cases, large flows were obtained when a hole was first drilled, and gradually tapered off as the water table dropped.

As a result of experience on this work, it is believed that, if exploratory holes have not been previously drilled and if time permits, such holes should be drilled to locate water-bearing seams, thereby reducing the number of exploratory drains. However, if an area starts to slide or if seepage is noted and a slide is anticipated, horizontal drilling should begin immediately at the base of the slide or at the seepage points. Once a slide starts it is harder to control,

and it becomes continually harder to control as it progresses.

The total cost of drilling and casing horizontal drains on this work averaged $1.83 per lin ft, including new equipment, training of personnel, and improvements in equipment. By early 1953 the cost of such work had decreased to about $1.50 per lin ft owing to familiarity with the procedure and improvements in equipment. The minimum cost for any one month has been $1.00, and the maximum $2.00 per lin ft installed. This variation is governed by the types of material encountered and the length and number of moves required.

Pump at toe of cut circulates water for drilling, as both drilling machines require a water feed to wash out cuttings and cool bits.

Big Slide Stopped

One big slide is of special interest. Over 5 million cu yd of material was involved in this slide, which had been temporarily stopped by pumping from a system of deep-drain wells. The excavation of a drainage tunnel was started for a permanent drain, but before the tunnel was finished, it was decided to try horizontal drilling at the head of the tunnel to provide permanent drainage at a much lower cost. Excavation of the tunnel was discontinued and a 12 × 12-ft chamber constructed from which to drill the horizontal holes in all directions.

The Hydrauger was chosen to do this drilling because an air-driven motor had to be used inside the tunnel. The first two horizontal holes drilled crossed a slip seam and enough water was tapped to permit discontinuance of the drain-well pumping system. A total of 16 horizontal drains were drilled in this chamber in approximately 300 deg of a circle and at various vertical angles. The total flow from the tunnel was increased by these drains from 16 gal per min to as much as 60, with an average of 45.

A board of consultants inspected this drainage system and were of the opinion that a 12-in. hole, cased with perforated, corrugated metal pipe back to the slip seam, would further insure the permanence of the drainage. This board also believed the 12-in. hole would complete the required drainage of the slide area to insure stability. To install this pipe a $4^1/_4$-in. pilot bit was first used, followed by a 6-in., a 9-in., and finally a $13^1/_2$-in. rotary bit. The 5.2-hp air motor on the Hydrauger was replaced with a 10-hp motor, and NX-rods were used. Clay, weathered basalt rock, fresh basalt rock, weathered rock, and clay in the seam were encountered, in that order. Very little trouble was experienced up through the 9-in. bit, but the $13^1/_2$-in. bit was very heavy for this type of equipment and also had a tendency to drop downward while drilling. The total length of the hole was 60 ft.

In the other area where the pumping of a deep drain-well system was used to prevent sliding, horizontal drains lowered the water table over 40 ft. This resulted in abandonment of the deep-well pumping system and eliminated the need for a drainage tunnel. The sudden drawdown of the water table caused an immediate settlement of about 6 in.

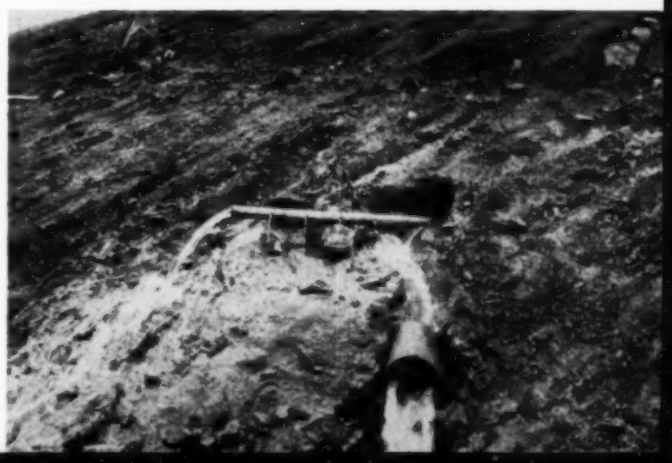
In one cut less than 1,000 ft long, about 150 gal per min is flowing from horizontal drains. One of these drains flowed as much as 140 gal per min when first drilled but tapered off gradually. In another cut a slide started, endangering a house above the cut. This cut was immediately horizontally drilled and all cracks were filled. This stopped the slide, and only minor dressing of the slope was required. These are only a few examples of the many successful results obtained by the horizontal-drainage method.

Some General Comments

It has been found that horizontal drains have a great influence in lowering hydrostatic pressures and in some cases may change the direction of seepage forces from driving to resisting. The extent of the influence on shear stresses will depend on the conditions and types of material.

The power auger was designed to drill horizontal drains; the Hydrauger was originally designed as an easy and economical method of installing underground pipe; and the core drill was designed to drill vertical holes and to take core samples. None of these machines is ideal for drilling horizontal drains under all conditions, but it is believed that a special drill machine could be designed for this purpose. Some other uses for a machine of this type would be on exploration for tunneling, drainage of subgrades in swamp areas, and relieving seepage pressures around structures.

Lookout Point Reservoir is under the supervision of the Portland District, Corps of Engineers. The District Engineer is Col. T. H. Lipscomb, and the Resident Engineer C. C. Davis, M. ASCE. The writer is grateful to these two men for their approval and support of the horizontal-drainage project. Grateful acknowledgment is also due R. J. Pope, Head, Soils Section, Portland District, Corps of Engineers, for initiating the installation of horizontal drains and for furnishing design studies and technical information. The work described was performed during the period 1950–1952.



Water flowing from individual drains, measured shortly after drains were installed, varied from zero to 140 gal per min. Last section of upper casing was later replaced with nonperforated pipe to prevent clogging of drain by roots.

Connecticut airport expanded to meet both commercial and military needs

The importance of careful planning of airport facilities is exemplified in the development of Bradley Field, Windsor Locks, Conn., as now being executed. Originally constructed as a military airfield and training base, Bradley Field had been well planned for that purpose alone. Before 1948, all commercial airlines serving the Hartford, Conn., area had been restricted to the use of Brainard Field, which was rapidly becoming overtaxed, and the facilities of which were inadequate to safely accommodate any aircraft larger than a DC-3.

Consequently, when in 1948 the federal government returned the Bradley Field facility, consisting of 1,600 acres, to Connecticut, the State Aeronautics Commission, under the able and enthusiastic chairmanship of Francis S. Murphy (then publisher of the Hartford *Times*), had already appraised the potentialities of its conversion into a major commercial airport to serve the Hartford, Conn., and Springfield, Mass., area, and had initiated a program for its development.

Importance of Master Plan

One of the first requirements of such a program was a long-range master plan. In September 1947 the architectural firm of W. Stuart Thompson and Phelps Barnum of New York was commissioned to prepare such a plan, in cooperation with Severud-Elstad-Krueger, structural and soil mechanics consultants, and the firm of Wohlpart and Hart, mechanical and electrical consultants. A complete survey of the then existing facilities was made and the findings and resulting recommendations incorporated in a comprehensive report, which was supplemented by three plans (Fig. 1).

The long-range master plan was influenced by certain existing conditions and fundamental requirements which demanded primary consideration. Among these were: (1) maximum use of existing facilities; (2) continuous operation of the airport during the construction periods; (3) combined commercial and military use and segregation of the taxi traffic patterns of the two types of aircraft; (4) ultimate separation of the rapidly increasing freight traffic from the passenger terminal area; (5) maximum ultimate runway lengths within the existing property lines; and (6) irregular topography of the southern end of the airfield.

Military considerations had originally dictated the location of the major maintenance, administrative and operational structures, including the control tower and beacon, along U.S. Highway 75 at the east side of the field. This would also normally be the logical location for a commercial passenger terminal, and in fact a temporary passenger terminal was for several years located in this general area. However, it was realized that because of its location, approximately midway between Hartford and Springfield, Bradley Field will serve a tributary population of over one million, in an industrial section that is growing steadily. The available space adjacent to the original apron No. 1 was found to be definitely inadequate to accommodate a passenger terminal, apron, and parking spaces with sufficient provisions for future expansion. Moreover, placing the terminal at that location would dislodge the essential existing structures and completely disrupt operation of the field as an airport, which since early 1948 had been serving commercial traffic that Brainard Field could no longer handle.

In general the topography of the military airfield was level, except towards the south end of the property, to the southwest of Runway C, where there were deep gulleys and an open gravel and sand pit. Studies proved that the use of this irregular terrain for future runway construction would not be feasible because of the large quantities of fill required. However, it would afford an ideal site for the new passenger terminal building, its parking apron, automobile parking areas, and a pleasing approach road.

The new terminal building is founded on a high, firm site. Grading for the new apron No. 2 provided ample fill material for the automobile parking areas and filled ramps of the upper road which serves the main floor of the building. The choice of this location for the passenger terminal, within reasonable proximity to existing water supply and sewer mains, has made it possible to satisfy all the fundamental requirements of the long-range plan. Except under instrument operating conditions, the north-south Runway A is the principal and most used runway. When the parallel Runway D is eventually constructed, the passenger terminal will be ideally located between the principal pair of north-south runways, thus entirely eliminating taxiing cross traffic by the commercial planes that use these runways.

Terminal Building in Operation

The new Francis S. Murphy Terminal Building, named for the chairman of the Connecticut Aeronautics Commission, was completed and put in operation in the autumn of 1952. It is a two-level terminal, providing complete separation of airline passenger traffic from baggage, express, cargo and mail. Passengers enter the terminal over an elevated roadway which serves the main-floor level. At this level all ticketing and baggage checking is done, the baggage being conveyed by chutes to the ground floor at the level of the main apron. Baggage from incoming flights enters the terminal at ground level and is transported by a belt conveyor up to the baggage pick-up counter on the main floor. On the main floor also there is an ample waiting room, with a view over the airfield, an air-conditioned lunch room, a barber shop, mercantile concession shops, and other facilities to serve the traveling public.

EDWIN A. HORNER, M. ASCE

Engineer,

W. Stuart Thompson and Phelps Barnum,

Architects, New York, N. Y.

Aerial view of Bradley Field, near Hartford, Conn., shows completed terminal building with its generous parking facilities and extension of Runway B already completed. Remainder of work to be done in Phase I is shown in Fig. 1.

Under the elevated passenger roadway, a trucking road at ground level gives access to the express, mail, and baggage handling departments of the individual airlines. All such traffic passes through the terminal without interfering with passengers, who reach their designated planes by means of widely separated stairs which lead through passenger gates enclosed within the building and opening directly onto the apron.

At the ground-floor level there is an employee cafeteria, toilet and locker rooms for employees, and food storage and preparation areas which are adjuncts to the main dining room and kitchen located one story above the main floor.

Bugetary requirements called for a self-supporting and self-liquidating terminal building. To accomplish this, special emphasis was placed on the provision of revenue-producing concessions to which the public would be attracted. Among these concessions, the main dining room, on the second floor, is of first importance. It may be reached either by a wide, inviting stair from the main concourse, or by a self-service elevator. The dining room, which seats about 250, is enclosed with Thermopane insulating glass on three sides to afford a sweeping view over almost the entire airfield. A part of the dining area can be shut off by a sliding partition to form a private dining room on special occasions. Both the dining room and the adjoining bar and foyer are air conditioned. Since the terminal opened, the dining room has been very popular and has exceeded all expectations as to revenue.

The third floor is almost entirely occupied by facilities of the Civil Aeronautics Administration, with a direct connecting stair to the air-conditioned control tower. The fourth floor is devoted to air-conditioning and ventilating equipment, and elevator penthouses. The entire building has a structural steel frame to permit future alterations if necessary.

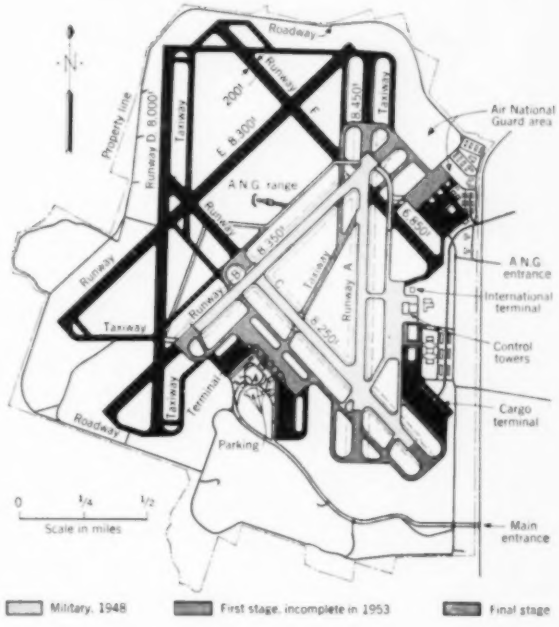


FIG. 1. First- and second-stage plans for expansion of Bradley Field are superimposed on plan of original military airport, as turned over to state of Connecticut in 1948.

The elevated road structure is of reinforced concrete, with rigid-frame bents at an average spacing of 19 ft 0 in. and a span of 34 ft 0 in. Form linings were constructed of Plyglaze plywood and then given an interior coating of Plykote before the reinforcement was placed. When forms were stripped, the exposed surfaces required a very minimum of rubbing and finishing.

Provision for Expansion

Although the terminal building was built on a centralized plan, with all its functions concentrated under one

roof, it has been planned in such a way that, as traffic volume grows and as the number of participating airlines increases, it can readily be expanded and converted into the decentralized type of plan that is essential for very large airports. The Connecticut Aeronautics Commission has planned the airport with the idea that at some time in the not-too-remote future it may be called upon to serve as a relief landing field for the New York metropolitan area. Overtures have already been made by one overseas airline for use of the field for direct overseas flights.

A spur of the New York, New Haven and Hartford Railroad, which runs along the east edge of Bradley Field, has recently had its permanence assured by being extended to serve the Hamilton-Standard Division of United Aircraft Corp., at the south end of the field. With the cooperation of the railroad, clearance of overseas flights through quarantine and immigration stations could be accomplished at the airfield, and all customs clearances could then take place aboard special trains giving virtually non-stop service directly into Grand Central Station, New York, N.Y. The total time consumed by such a service would compare favorably with that now required for clearing overseas passengers, considering the delays experienced with the present system.

The total cost of the Terminal Building, including mechanical equipment and the approach road structure and parking area enclosed by it, was approximately $1,857,000.

Facilities for the Air National Guard have been located in the northeast part of the field to separate this service entirely from the commercial airlines terminal. By this arrangement the ground traffic of commercial and military planes is kept separated to a very large degree. A new hangar and a new apron have been built by the U. S. Army Engineer Corps for the Air National Guard. For the past 18 months the hangar has been under lease to the Kaman Aircraft Corporation while the Air National Guard has been assigned to active duty elsewhere. Other structures for military use will be built in the vicinity as the need arises and as funds become available.

Summary of Work Done

1. **Master plan (drawings and report)**
   Architects, W. Stuart Thompson & Phelps Barnum, New York
   Structural and soil mechanics work, Severud-Elstad-Krueger, New York
   Mechanical and electrical work, Wohlpart & Hart, New York

2. **New approach road (from Route No. 75 to new terminal building)**
   Consulting engineer, John J. Mozzochi, Glastonbury, Conn.
   Contractor, Enfield Road Construction Co., Thompsonville, Conn.
   Cost, $184,453.22

3. **New main apron (at new terminal)**
   Consulting engineer, John J. Mozzochi
   Contractor, Henley-Lundgren Co., Shrewsbury, Mass.
   Cost, $416,071.36

4. **New terminal building**
   Architects, W. Stuart Thompson & Phelps Barnum, New York
   Structural Engineers, Severud-Elstad-Krueger, New York
   Mechanical engineers, Jaros, Baum & Bolles, New York
   Electrical engineers, Smith & Silverman, New York
   General contractors, The Associated Construction Co., Hartford, Conn.
   Cost, approximately $1,856,000

5. **Extension of Runway B and connecting taxiway**
   Engineered by the U. S. Army Engineers
   Contractor, Zielinski Brothers, Agawam, Mass.
   Cost, approximately $500,000

6. **High-intensity lighting**
   Consulting engineer, Arthur T. Flynn, Wetherfield, Conn.
   Contractor, Bauer and Son Co., Hartford, Conn.
   Cost, $60,000

7. **Relocation of night lighting equipment (from old tower to new control tower)**
   Consulting engineer, Arthur T. Flynn
   Contractor, Interstate Electric Co., Hartford, Conn.
   Cost, approximately $125,000

8. **Connecticut Department of Public Works**
   Ralph G. Macy, Commissioner

9. **Connecticut Department of Aeronautics**
   Kenneth H. Ringrose, Director, Donald J. Lynch, Airport Engineer

Runways Lengthened

When the airfield was turned back to the state, the lengths of Runways A, B, and C were 5,200, 5,000 and 5,000 ft respectively, and the width of their asphaltic concrete paved surface was in each case 300 ft to satisfy military requirements. Since such an excessive width is not required for commercial operations, one of the primary recommendations of the master plan was the reduction of the operating widths of all runways to 200 ft. It was also recommended that, in the first stage of development the lengths of Runways A, B, and C should be lengthened to 7,000 ft, 6,275 ft, and 6,000 ft respectively to accommodate the longer-range four-engine and jet-engine aircraft.

The first step taken in this direction was the recent lengthening of the instrument Runway B by an extension of 1,700 ft to the south, which provides an operating length of 6,700 ft. This is a compromise between the recommended first- and second-stage plans shown in Fig. 1.

The cross section of this runway extension consists of a compacted subgrade, over which a 3-in. layer of screening was applied. Over the screening was laid a $3\frac{1}{2}$-in. dry-bound macadam base, followed by a prime coat, a $1\frac{1}{2}$-in. bituminous course, a tack coat, and finally a $1\frac{1}{2}$-in. bituminous wearing surface.

To supplement the purely technical information available from the report prepared by the U. S. Engineer Office at Providence, R.I., a general survey was made of the paving, which was found to be generally in excellent condition. The history of the field was sufficient to prove that no major weaknesses of any kind were likely to exist and that the field had not begun to reach its full load-carrying capacity. No evidence could be found of frost heaving or cracking in areas overlying the glacial till, even as a result of the severe winter of 1947–1948.

Recommendations Based on Survey

On the basis of this information, it was recommended that no strength-

ening of runways need be done until some time in the future, when justified by appreciable increases in aircraft wheel loads and frequency of aircraft operations. This recommendation was also based on the following conclusions:

1. The existing runways are capable of supporting plane loads up to 120,000 lb for limited operations, "limited operations" being defined as: (*a*) A few operations of maximum capacity per day over a period of 20 years, or (*b*) the maximum traffic that can possibly operate for a period of two to four years.

2. It is to be assumed that certain weaknesses will develop at the juncture between old and new paving. A period of observation of these conditions is recommended before any existing runways are strengthened.

3. It is expected that warm-ups will continue to add to the safety factor of the existing construction.

These conclusions have been proved correct by recent investigations conducted by the U. S. Army Engineers and the Connecticut Department of Aeronautics just prior to the recent extension of Runway B. It was found that continued use of the field and the vibration of the planes landing and taking off had compacted the subbase to such an extent that the permissible wheel load had increased substantially over the original design load of 60,000 lb.

Although strengthening of existing runways and taxiways has not been required, a sealer coat of bituminous concrete and stone chips has been applied, as recommended in the master-plan report.

The situation at the site of the new apron No. 2 presented a special problem. Over a considerable area within its limits there were asphaltic apron pavements which were in very good condition. Four possibilities presented themselves: (1) to extend the existing aprons, using the same type of pavement; (2) the same as (1) but with a view to pouring a concrete apron on top at a future time; (3) to construct a concrete pavement resting partly on the present apron construction and partly on the compacted apron; (4) to break up the present earth construction and pour a completely new concrete apron.

Method No. 1, while the least expensive, was ruled out because of the limited carrying capacity thereby provided, and because of the undesirability of asphaltic paving for a permanent apron on account of the deleterious effects of oil spillage.

Method No. 2 was not acceptable because it would handicap operation

Francis S. Murphy Terminal Building is two-level structure providing complete separation of passengers from baggage, express, cargo, and mail traffic. Building is framed with structural steel (top view) to permit future alterations if necessary. Ample provision has been made for incorporating revenue-producing facilities. One of most successful is Thermopane-enclosed dining-room, seen in center photo, on north side of building. Bottom photo shows part of parking area and cargo and baggage-handling area.

of the field when the concrete cover was to be poured. Also, water seepage through the concrete pavement would accumulate on the asphaltic pavement below and cause frost heaving.

Method No. 3, in addition to the reasons stated above, presents the danger of unequal settlement and resulting cracks along the edges of the present asphaltic pavement.

Method No. 4, while the most expensive, was considered to be the only safe procedure to follow, since a durable and satisfactory apron at the passenger terminal building is a paramount necessity.

That part of the new apron No. 2 which has been completed is 300 ft wide and 1,200 ft long, and will accommodate eight four-engine-plane positions. Ultimately it is planned to provide accommodations for 19 plane positions.

Concrete Apron Construction

The new 200-ft-wide apron, adjacent to the building, is 11-in. reinforced concrete pavement. All longitudinal bars in the reinforcing mat are $^3/_8$ in. in diameter and all transverse bars are $^1/_4$ in. in diameter, each mat being approximately 11 ft long, divided into 10 spaces at 1-ft intervals. The total weight of mat reinforcement in each 120-ft × 12-ft 6-in. slab is approximately 1,012 lb. Standard load transfer units were used at all transfer joints. Slabs were tied together with a dowel expansion joint. Dowels are smooth, of $1^1/_4$-in. diameter and 20-in. length. The concrete apron slopes on a 1-percent grade toward the center, where all drainage is picked up in a scupper and carried off the apron.

The 100 ft of apron farthest from the building is of black-top construction. A 10-in. water-bound macadam base-course was placed in two layers and surfaced with 3-in. dense-grade bituminous concrete placed in two layers. This black-top portion of the apron pitches away from the building on a 1.03-percent grade. At each plane position, an electrical manhole is provided which gives access to four 3-in. electrical ducts. Each plane position also was provided with a 6 × 12-ft knock-out slab for a future gasoline pit. At each of these future pits, three 4-in. steel pipes were installed under the apron.

Water Supply and Sewerage

The original military airfield had its own complete water supply system, still in operation, which consists of electrically powered pumping stations and underground reservoirs, the supply being obtained from five wells. At present this system is supplying an average of 1 million gpd to the Hamilton Standard Division of United Aircraft Corp., and still supplies the airport itself with all necessary water.

The field was also equipped with a sewage disposal system with two separate plants. One plant consists of two Imhoff tanks, three sets of filters, three settling tanks, and three sludge beds. The other consists of one Imhoff tank, one filter, one settling tank, and one sludge bed. The entire system is in good condition and is capable of serving a community of 25,000 permanent residents. Today it adequately serves all needs of the airport plus the new factory building for the Hamilton-Standard Division of United Aircraft Corp. It is expected that the water supply and sewerage systems will, if properly maintained, be adequate to meet all future demands within the boundaries of the airport property.

As a part of the extension of the instrument Runway B, a new system of Barto controllable-beam, high-intensity lighting was installed on this runway at a cost of $60,000. Controls for all night lighting equipment have recently been moved from the old control tower to the new tower of the Murphy Terminal Building, and approximately 150 additional taxiway lights have been installed in the area close to the building.

The Connecticut Department of Aeronautics is charged with the planning and development of Bradley Field, together with its operation and maintenance.

Preliminary planning and financing was initiated under the Real Assets Division, Office of the Comptroller, State of Connecticut, of which Arthur G. Beaulieu, M.ASCE, was then Division Director. However this division has been superseded by the State Public Works Department, which has let all contracts for construction of the projects.

How would you do it?

Some of the most fascinating chapters in the life and memory of an engineer are those which deal with the unusual and unexpected situations which almost got him down but from which he finally emerged the victor.—H. J. Gilkey

A 3,880-ft section of the 18-year-old Coney Island boardwalk in New York had to be moved inshore to provide greater beach area. The new line was almost straight and placed the structure generally about 250 ft inshore from the original location, the maximum departure being about 325 ft.

The walk, a conventional trestle with a deck-supporting stringer system of creosoted timber, was found in such splendid condition that the material was reused in the new structure almost in its entirety. The deck and the stringer system were supported on reinforced-concrete pile bents. Each bent consisted of four concrete piles with a 40-ft reinforced-concrete cap, two bents being placed end to end to provide the required width of 80 ft. An opening of 1 in. for expansion was left at the center line of the structure between the ends of the two caps. Various plans for moving the bents were put forth—how would you do it? For solution, see page 92.

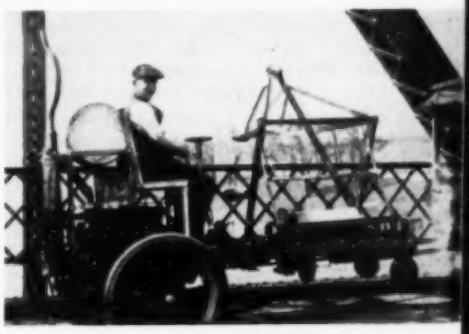
EDITOR'S NOTE: This is the eighteenth in a series which started in the February 1952 CIVIL ENGINEERING. In the April 1952 issue an article, "The Unexpected in Engineering: The Bugs," explains the project and enlarges upon the central theme that problems of the past created the practice of the present; that "The engineering of today rests upon a coral reef; sturdy remnants of yesterday's bugs." The process is a continuing one; there will always be today's and tomorrow's bugs to add zest and gray hairs to the practice of a profession that by its very nature must cantilever from a codified past to an untried future. "Long live bugs" is an ever-present challenge to the virility and ingenuity of the engineer. If you have a good bug, why not share it? H. J. G.

The above problem was submitted by RALPH H. MANN, M. ASCE, New York, N. Y.

Small tractor cranes help make stream measurements for U.S.G.S.

ARTHUR H. FRAZIER

Chief, U.S. Geological Survey Equipment Development Laboratory, Columbus, Ohio



First trailer-mounted apparatus for easing laborious work of Geological Survey stream gaging was queer-looking contraption. Swinging current meter weighted with 200 or 300 lb of lead over side of a bridge, at 30 to 50 points across a river like the Mississippi, and handcranking it up and down, is no job for weaklings.

In its earlier years, measurements of river depth and current speed were made by the U.S. Geological Survey laboriously by hand. Since these measurements are taken every 5 to 50 ft or so across a stream (depending on its width), they are quite a chore on wide rivers, particularly the Mississippi. During the early 1930's, instrument makers mounted a boom on a trailer attached behind a truck. It was crude, but for gaging deep, swift streams it saved a lot of time and manual labor—also it gave more accurate results. During the years since that boom was built, gradual improvements were added as each new model was designed.

The arrangement shown in the accompanying photographs—the latest to be devised—appears to be just about ideal for this work. Its cost, including the vehicle, is between $1,800 and $2,000. Three such cranes, built for use at U.S.G.S. gaging stations on the Mississippi River, are now in regular service at Vicksburg, Memphis, and St. Louis.

All three were constructed at the Survey's Equipment Development Laboratory (Water Resources Division) in Columbus, Ohio, largely from standard parts produced by commercial manufacturers. They are mounted on a 4-ft-wide Crosley Farm-O-Road tractor, a vehicle described as a cross between a midget automobile and a farm tractor. Its narrow width and light weight permit it to be used on the sidewalks of many bridges, thereby eliminating interference with vehicular traffic.

One of the Survey's assigned tasks is keeping a record of the nation's water resources, particularly measuring the amount of surface water available at key locations along the rivers and creeks. Computing the number of acre-feet flowing by any particular point each day is accomplished by continuous records of water level coupled with periodic measurement of stream width and depth, and the speed of the current. The data, collected at 6,500 Survey stream-gaging stations in the United States, Alaska, and Hawaii are essential for flood control work, river navigation, irrigation, municipal water supplies, pollution prevention, power development and a host of other important uses. Streamflow measurements are basic elements in engineering design wherever structures are adjacent to waterways or dependent in any way on the amount of flow.

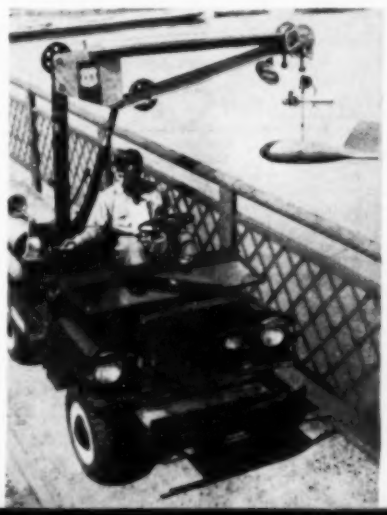
The width of a stream is easily measured. Except for floods and drought periods, this element remains fairly constant.

Current meters consisting of anemometer-like instruments with cups whirled by moving water give accurate data on current speed. Depth is measured at the same time by weighting the current meter with up to 300 lb of lead (shaped like a fish) and noting the amount of cable paid out when the weight travels from the surface to the bottom of the river. The lead sounding weight steadies the instrument and keeps it facing upstream.

In the new arrangement, the crane has a special boom which can be rotated through 360 deg and adjusted to practically any desired vertical angle by means of a manually operated fluid jack. An 8.4-in. "hydro-sheave drive" is mounted at the end of the rear power take-off, and the necessary power for raising sounding weights up to the 300-lb size is transmitted to the reel through multiple V-belts.

While the vehicle motor idles, very little torque is developed in the hydro-sheave drive. Hence the sounding weight and current meter can be lowered by merely releasing the reel brake. When the motor is accelerated (with the brake on the reel released) sufficient torque is pro-

With newly developed, "self-propelled" crane, engineering aid measures flow in Mississippi at St. Louis (above and below). Current meter and 200-lb sounding weight can be speedily raised or lowered through fluid-clutch connection to engine of Crosley Farm-O-Road tractor, specially adapted for stream gaging by Equipment Development Laboratory, Water Resources Division, U. S. Geological Survey.



duced in the fluid clutch to raise the sounding weight. The faster the motor operates, the faster the reel revolves, pulling the meter up from the water. In taking his measurements, the operator moves the vehicle from station to station on a bridge without disengaging the power take-off, and the meter can be left in the water if there are no lamp posts or structural bridge members that the boom would hit.

All operations required to raise and lower the weighted current meter are performed from the driver's seat. The meter is lowered until slackened tension in the line indicates the bottom has been reached, providing data on stream depth. Backing the reel a few feet raises the instrument to the desired position for velocity readings. The "bucket wheel" makes an electrical contact every fifth revolution, and the operator, wearing earphones, counts the number of clicks heard over a 40- to 70-sec interval. From prepared tables he translates the number of bucket-wheel revolutions during the observation period into water speed, makes his entry for that position, and moves on to the next.

The vehicles now in operation are provided with heaters, tops, and side curtains to protect the operators during inclement weather. The apparatus has proved to be most practical on high bridges that have relatively few lamp posts or structural members to interfere with the swinging of the boom, and which have cantilevered sidewalks wide enough so that the vehicle can be driven along them.

ENGINEERS' NOTEBOOK

Stirrup spacing in beams rapidly determined

JACK MOYSE, Structural Engineer, Thomas J. Nolan & Sons, Louisville, Ky.

To aid the designer in the rapid computation of stirrup spacing, with particular application to the case of uniform load, the following equations have been developed. They are believed to be original and simpler than any now in use.

Assuming the shear triangle, Fig. 1, divided into n equal areas, the area of each unit is

$$\left.\begin{aligned} A_x &= \frac{ah}{2n} \\ A_x &= \frac{h_x l_x}{2x} = \frac{h_{x+1}l_{x+1}}{2(x+1)} = \\ &\qquad \frac{h_{x-1}l_{x-1}}{2(x-1)} \end{aligned}\right\} \quad . \; . \; . \; (1)$$

$$h_x = \frac{h\,l_x}{a};\; h_{x+1} = \frac{hl_{x+1}}{a};\; h_{x-1} = \frac{hl_{x-1}}{a} \quad (2)$$

Hence

$$\left.\begin{aligned} l_x &= a\left(\frac{x}{n}\right)^{1/2} \\ l_{x+1} &= a\left(\frac{x+1}{n}\right)^{1/2} \\ l_{x-1} &= a\left(\frac{x-1}{n}\right)^{1/2} \end{aligned}\right\} \quad . \; . \; . \; (3)$$

Arm to center of gravity of A_x is

$$a_x = \frac{1}{A_x}\left[A_x(x)\left(\frac{2}{3}l_x\right) - A_x(x-1)\left(\frac{2}{3}l_{x-1}\right)\right]$$

Substituting Eqs. 3 and clearing,

$$\left.\begin{aligned} a_x &= \frac{2a}{3\sqrt{n}}\left[x^{3/2} - (x-1)^{3/2}\right] \\ a_{x+1} &= \frac{2a}{3\sqrt{n}}\left[(x+1)^{3/2} - x^{3/2}\right] \end{aligned}\right\} \quad . \; . \; . \; (4)$$

Hence

$$S_x = (a_{x+1} - a_x) = \frac{2a}{3\sqrt{n}}\left[(x+1)^{3/2} - 2x^{3/2} + (x-1)^{3/2}\right] \quad . \; . \; . \; (5)$$

$$S_n = a - a_n = a - \frac{2a}{3\sqrt{n}}\left[n^{3/2} - (n-1)^{3/2}\right] \quad . \; . \; . \; (6)$$

Expanding by series to four terms, convergence is very rapid:

$$\left.\begin{aligned} (x+1)^{3/2} &= x^{3/2} + \frac{3}{2}x^{1/2} + \frac{3}{8}x^{-1/2} + \frac{1}{16}x^{-3/2} \\ -2x^{3/2} &= -2x^{3/2} \\ (x-1)^{3/2} &= x^{3/2} - \frac{3}{2}x^{1/2} + \frac{3}{8}x^{-1/2} - \frac{1}{16}x^{-3/2} \end{aligned}\right\} \Sigma = \frac{3}{4\sqrt{x}} \quad . \; . \; . \; (7)$$

$$S_x = \left(\frac{2a}{3\sqrt{n}}\right)\left(\frac{3}{4\sqrt{x}}\right) = \frac{a}{2\sqrt{n}x}$$

$$S_n = a\left[1 - \frac{2}{3\sqrt{n}}\left(n^{3/2} - n^{3/2} + \frac{3}{2}n^{1/2} - \frac{3}{8}n^{-1/2}\right)\right] = a\left[1 - 1 + \frac{1}{4n}\right] = \frac{a}{4n} \quad . \; . \; . \; (8)$$

$$S_x = \frac{a}{2\sqrt{nx}} = \left(\frac{a^2}{4\,nx}\right)^{1/2} \quad . \; . \; . \; (9)$$

Combining Eqs. 8 and 9 results in the final equation for spacing

$$S_x = \left(S_n \frac{a}{x}\right)^{1/2} \quad . \; . \; . \; . \; (10)$$

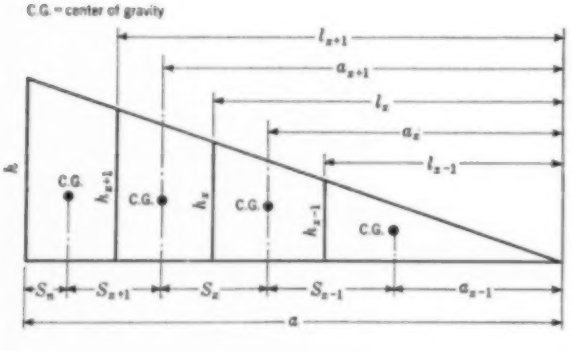


FIG. 1.

Typical Example Solved

It is assumed that $f_c = 3$ kips per sq in. and $f_s = 20$ kips per sq in. Allowable unit shear = 90 psi in concrete.

$w = 2$ kips per ft; $b = 12$ in.; $d = 10$ in.

(Vol. p. 698)

Use $^3/_8$-in. round stirrups, U-shaped.

$V = 17.5$ kips; $V_s = 17.5 - 0.079\,bd = 17.5 - (0.079 \times 12 \times 10) = 8$ kips

$$c = \frac{0.343}{A_v} = \frac{0.343}{0.22} = 0.13$$

$$a = \frac{12\,V_s}{w} = \frac{12 \times 8}{2} = 48 \text{ in.}$$

$$n = \frac{c\,a\,V_s}{d} = \frac{0.13 \times 48 \times 8}{10} = 5.1$$

Assume $n = 6$; $S_n = \dfrac{a}{4n} = \dfrac{48}{4 \times 6} = 2$ in.

$a\,S_n = 48 \times 2 = 96$

Then

$S_5 = \sqrt{\frac{96}{5}} = 4$ in.; $S_4 = \sqrt{\frac{96}{4}} = 5$ in.;

$S_3 = \sqrt{\frac{96}{3}} = 6$ in.; $S_2 = \sqrt{\frac{96}{2}} = 7$ in.;

$S_1 = \sqrt{96} = 10$ in.

Say, space the stirrups 2, 5, 5, 5, 7, and 10 in.

Note that all computations can be made mentally, as results are always rounded off to the nearest inch.

This is believed to be the first time this method of stirrup spacing design has been proposed. Its use should greatly lessen the time and labor of the designer, with a resulting reduction in errors.

Notation

a = length, in inches, of shear triangle to be carried by stirrups
A_v = total area of stirrup legs, in square inches
A_x = any equal unit area of shear diagram
a_x, a_{x+1}, a_{x-1} = distance from apex of shear triangle to center of gravity of corresponding unit area
b = width of beam stem, in inches
c = constant, dependent on size of stirrup and f_s, $= \dfrac{6}{A_v f_s j}$
d = effective beam depth, in inches
f_c = allowable concrete stress
f_s = allowable steel stress
h = height of shear triangle at support
h_x, h_{x+1}, h_{x-1} = height of shear diagram at points corresponding to a_x, etc.
j = assumed value of 7/8
l_x, l_{x+1}, l_{x-1} = distance from apex of shear triangle to respective heights
n = number of stirrups or number of unit areas into which shear triangle has been subdivided
S_x = spacing between stirrups at any point, x
V = total shear on beam
V_s = shear carried by stirrups
w = uniform load on beam
x = any point with origin of x at apex of shear triangle

Dimensionless curves aid design of flexible arch ribs

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Associate Professor of Civil Engineering

SIDNEY SHORE, J.M., ASCE,
Assistant Professor of Civil Engineering

Princeton University, Princeton, N. J.

In the design of statically indeterminate structures, early evidence on approximate stresses and properties of sections saves considerable time in determining the final acceptable structure. In the case of flexible arches, of which few have been designed, the first approximation of the properties of the section is complicated because superposition of effects is not applicable.

In the so-called elastic theory, which has been used in the design of structures for many years, displacements causing a change in the geometry of the structure are generally neglected. The errors involved are small if the corresponding displacements are small. If the elastic displacements are appreciable, the resulting change in the geometry of the structure becomes a factor which must be included in the design. Arches in this latter classification are those considered here.

One approach to the problem is through experimental data in the form of dimensionless curves obtained from a model arch. In this manner a broad range of geometrically similar arches is covered. Three steel arches of circular axis and constant moment of inertia, with various end fixities, were investigated in the Princeton Laboratory tests. However, this paper is based on the model arch with a ratio of span to rise of 6.29, and with fixed ends. Most of the arches designed today have a similar ratio of span to rise.

The arch was loaded by lead weights to simulate both dead and live loads. The dead loads were designed such that the thrust line closely followed the neutral axis of the arch rib. The live loads were made uniform, and their position to produce maximum moment for any point was then determined experimentally.

For a detailed description of the arches and the testing techniques see *Model Arches in the Flexible Range—Testing Technique*, Proceedings of the Society for Experimental Stress Analysis, Vol. IX, No. 2, pp. 31–42.

The following notation is used here:

E = modulus of elasticity
H = rise of arch
I = moment of inertia of section
L = span of arch or a linear dimension
L/H = ratio of span to rise = 6.29
LL = live load in load per unit of length
M = bending moment or maximum observed bending moment on model, in inch-pounds
R = ratio of dead load to live load
W = dead load intensity, in load per unit of length at crown
π = a dimensionless group or numeric
Positive bending moment = compression in outer fibers
Negative bending moment = tension in outer fibers

To apply the results of the model investigation to a practical problem, it is necessary to convert the observed bending moments of the model arch to corresponding bending moments of a geometrically similar prototype. To do this the principles of similitude governing the behavior of a model and its prototype can be established in two ways. First, the conditions

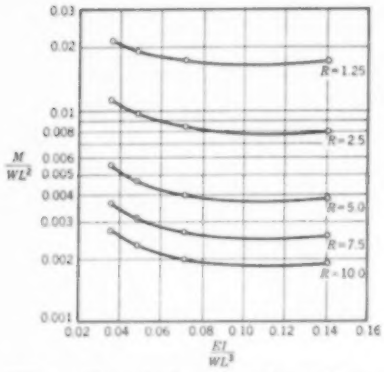


FIG. 1. Dimensionless curves for maximum positive bending moment at springing line.

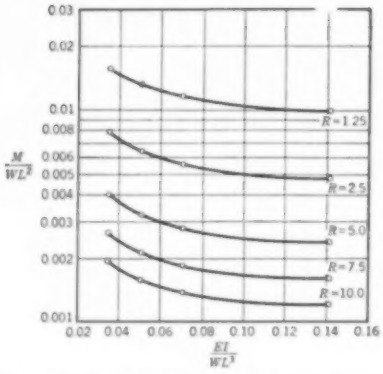


FIG. 3. Dimensionless curves for maximum negative bending at the springing line.

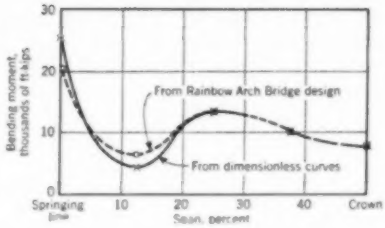


FIG. 5. Comparison of maximum positive bending moment as determined from dimensionless curves and from theoretical values for Rainbow Arch Bridge.

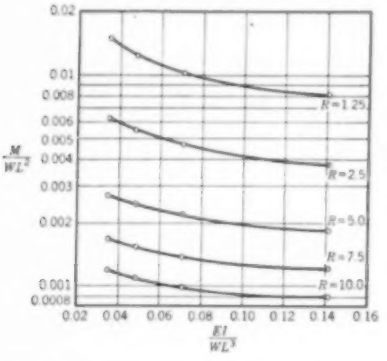


FIG. 2. Dimensionless curves for maximum positive bending moment at the quarter point.

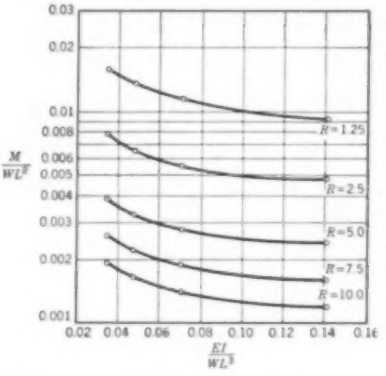


FIG. 4. Dimensionless curves for maximum negative bending moment at quarter point.

of similarity can be written mathematically by the laws of mechanics, and the principles of similitude then derived from them. Second, the principles may be obtained by the method of dimensional analysis and the Buckingham pi theorem. The first method is generally used for structural models, since the physical laws the structure follows are known, whereas the second method is used when the physical laws are not well defined, but the factors affecting the phenomenon are known. Since the general form of the laws governing the behavior of the arch model are known from structural mechanics, the first method was used in this study, following the two conditions for static similitude:

1. The model shall be geometrically similar to its prototype except for the dimensions that do not affect the behavior of the model.
2. The force scale reduction factor shall be the same for weight forces and elastic forces.

From these relationships, π groups, or dimensionless quantities, are determined. These dimensionless quantities are identical for any geometrically similar arch as long as a consistent set of units is used in their evaluation. Thus to utilize the experimental data to the best advantage, the maximum bending moments, M, observed on the model, together with the corresponding values of W, were substituted in the π groups M/WL^2 and EI/WL^3. The modulus of elasticity for the model was found previously to be 29,520,000 psi.

The two numerics or π groups are plotted against each other for various values of the parameter R (Figs. 1 to 4), to a vertical logarithmic scale so that values will remain within reasonable plotting limits and so that the percentage error will remain essentially constant for all ratios of R. Only the maximum positive and negative bending moments for the springing line and the quarter point are shown here, since these are usually the critical sections in the design of arches, although observations were made for other points along the arch.

To demonstrate the usefulness of these dimensionless curves for the preliminary design of flexible arches, the results obtained from the charts will be compared with those from an actual design. The following data, for the fixed-end condition, are taken from the symposium on the Rainbow Arch Bridge (ASCE TRANSACTIONS, Vol. 110, 1945):

L = 950 ft
H = 150 ft
I = 88.20 ft⁴ (quarter point)
W = 7.25 kips per ft at crown
LL = 1.38 kips per ft
R = 5.25
E = 29,000,000 psi

From these values,

$$\frac{EI}{WL^3} = \frac{29{,}000{,}000 \times 88.20 \times 144}{7.25 \times 1{,}000 \times (950)^3} = 0.0591$$

The value of M/WL^2, from which the maximum positive bending moment at the quarter point is determined, is obtained from the dimensionless curve (Fig. 2) by entering at the bottom with an abscissa of $EI/WL^3 = 0.0591$, then moving vertically up to the value of $R = 5.25$, and then horizontally to the value of $M/WL^2 = 0.0021$, from which M = 13,700 ft-kips. In a similar manner, values may be determined for other points along the arch axis.

A comparison of the envelope curves for values of maximum positive bending moment due to live and dead loads determined from the curves, and those determined from the Rainbow Arch Bridge symposium are shown in Fig. 5. Values computed from the symposium are approximate, because the bending moment due to impact had to be estimated.

It should be noted that the Rainbow Bridge has a variable moment of inertia and parabolic axis, whereas the model arch has a constant moment of inertia and circular axis. To give identical results, the model and prototype would have to be geometrically similar. Nevertheless, the values determined from the curves would have been exceptionally good for the preliminary design.

THE READERS WRITE

Bolted cantilever design for "welded warehouse" submitted to save steel and other costs

TO THE EDITOR: I read the article, "Savings on Welded Warehouse Begin on Designer's Desk," by David R. Graham, in your August issue, with great interest. However, I feel that the title is actually a misnomer, since in my opinion the most economical design for the given conditions was not obtained.

There has been an ever-increasing trend towards the use of continuous steel structures due to, among many other factors, the desire to conserve material by a more uniform proportioning throughout the entire structure. Undoubtedly this trend is an excellent one and should be followed whenever the end result is a more economical structure.

Mr. Graham has shown an all-welded, continuous design which required 2.75 lb of steel per sq ft (excluding joists) as compared to a similar framing layout wherein all the members are simply supported, which would have required 4.33 lb of steel per sq ft. With these figures as a basis, he computes that a saving of almost $22,000 was realized. On the surface it appears that a steel saving of about 38 percent has been made by the expedient of utilizing a fully continuous design. However, there is a fallacy in this reasoning. While the framing layout worked well with the all-welded structure, a different and more economical layout should have been used for the simple structure. I have taken the liberty of indicating this in the accompanying Fig. 1.

Since the design loading was not given, I obtained it by using the 120-ft-kip moment on a span of 40 ft carrying 20 ft of roof. This proved to be 30 or 20 psf live load, 9 psf dead load, and 1 psf for bar joists. The girders are 18WF50 sections, which rest on top of the columns and have a 7-ft cantilever at each end. Supported on the girders is a 16 WF 45 section, whose net span is 26 ft. The remainder of the framing is composed of long-span joists No. 224, which weigh 15 lb per ft. The bottom chord of all joists framing into columns should be extended to the columns so as to provide lateral support. A comparison of the weights used in the all-welded design and in the cantilever-type design is tabulated.

The results show a 6-percent steel saving in the cantilever-type design. Although the price for joist steel is slightly higher than it is for rolled sections, the simply supported beam framing would still be more economical for the following reasons:

1. Less steel is required.
2. Time-consuming and costly structural welding is eliminated.
3. Rigid welding inspection is not needed.
4. Cantilever-type framing would require bolted connections only. The beam-to-girder connection would be of the simplest type—two plates bolted to the webs.
5. The additional shopwork required for haunching all 14WF30 beams would be eliminated.
6. Half the number of joists, and consequently half the number of joist-to-beam connections, would be eliminated.

Much greater ease, and therefore rapidity of erection, would result for the above reasons.

In conclusion, I would like to say that although the use of continuity may, in most instances, require less steel, it must always be borne in mind that the cost of the additional shop and field work necessary to obtain the desired continuity may offset all the steel savings.

A. SELNICK
New York, N.Y. *Structural Designer*

Analysis of steel weights

WELDED DESIGN, FULLY CONTINUOUS

Girders	1 × 40 × 50 =	2,000
Beams	2 × 40 × 30 =	2,400
Joists	10 × 20 × 7.4 =	1,480
Total (lb per bay)		5,880
÷ 1,600	3.68 lb of steel per sq ft	

BOLTED DESIGN, CANTILEVER TYPE

Girders	½ × 54 × 50 =	1,350
Beams	½ × 26 × 45 =	585
Joists	6 × 40 × 15 =	3,600
Total (lb per bay)		5,535
÷ 1,600	3.46 lb of steel per sq ft	

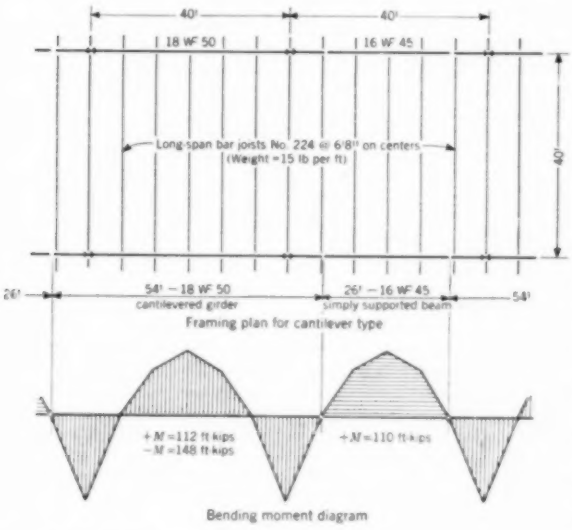


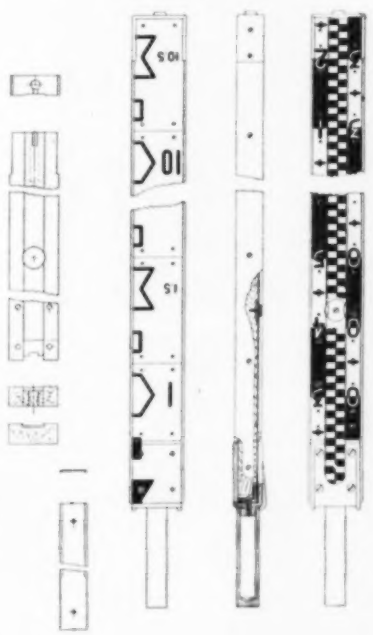
FIG. 1. Bolted cantilever design for "welded warehouse" is based on live load of 20 psf and dead load of 9 psf, plus weight of framing. In bending moment diagram, maximum moments are total design moments.

Level-rod illustration turned upside down

TO THE EDITOR: My little article on the Coast and Geodetic Survey's geodetic level rod (August 1953 issue, p. 62) appears very advantageously and has received favorable comment here. I do wish to call to your attention, however, the fact that the illustration has been turned around so that the footpiece points upward instead of downward. Normally, the rod figures are upside down, as we use an inverting eyepiece on our levels.

D. L. PARKHURST
Chief, Instrument Division
U. S. Coast and Geodetic Survey
Washington, D.C.

Editors Note: The cut is reproduced again below in correct position.

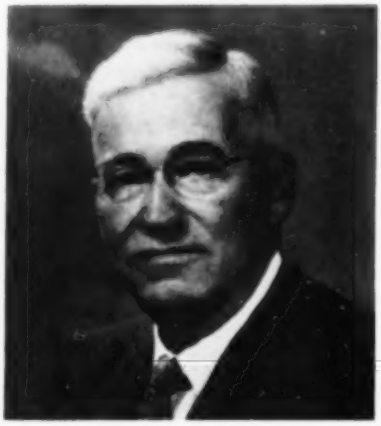


SOCIETY NEWS

New ASCE Officers to Be Inducted at Annual Convention

In the fourth ASCE election since adoption of the new Constitution, the Society has elected a President, two Vice-Presidents, and six Directors. The results of the balloting are announced on page 70. For the first time since adoption of the new Constitution necessitated some changes in the length of the terms of office, all the new officers will be inducted at the Annual Meeting in October and all will serve routine terms—a year for the President, two years for the Vice-Presidents, and three years for the Directors.

A biographical sketch of Daniel V. Terrell, newly elected President of the Society, appeared in the July issue, following his nomination for the presidency. Brief biographical sketches of the other new officers follow.



Daniel V. Terrell, dean of the College of Engineering and director of the Engineering Experiment Station at the University of Kentucky, will take office as 85th President of ASCE on Wednesday, October 21. Dean Terrell's long service to ASCE includes terms as Director and Vice-President.

Enoch R. Needles

Enoch R. Needles, newly elected Vice-President for ASCE Zone I, is widely known as a consulting engineer. Born in Missouri and a graduate of the Missouri School of Mines, Mr. Needles had his early engineering experience in the Middle West, with emphasis on the design and construction of bridges. He opened an office for his firm in New York in 1922, and has since made the city his business headquarters. In 1928 he became a partner in the firm of Ash, Howard, Needles & Tammen, of New York and Kansas City, and the firm name was changed to Howard, Needles, Tammen & Bergendoff in 1940. During the period, 1928 to 1940, the firm was especially active in bridge work, notably a group of major structures over the Mississippi River at Natchez, Greenville, Rock Island and Dubuque.

Early in World War II Mr. Needles served as resident partner for his firm on the Southwestern Proving Ground at Hope, Ark., and on the Bluebonnet Ordnance Plant near Waco, Tex. In December 1942 he entered the Corps of Engineers as lieutenant colonel and was promoted to colonel in July 1944. When he left the army at the end of the war he received the Legion of Merit.

Upon his return to practice Mr. Needles gave particular attention to the design and construction of the Delaware Memorial Bridge and the Old Lyme-Old Saybrook Bridge in Connecticut. However, his principal attention since 1946 has been directed to the financing, design, and construction of major expressways and turnpikes, including the Maine, New Jersey, and West Virginia turnpikes.

A member of ASCE since 1925, Mr. Needles was Director from 1937 to 1939, and later was president of the Metropolitan Section. He has been president of both the American Institute of Consulting Engineers and the American Road Builders Association.

ENOCH R. NEEDLES
Vice-President, Zone I

Mason G. Lockwood

Mason G. Lockwood, Houston, Tex., consultant and president of the Texas Section, is the newly elected ASCE Vice-President for Zone IV. A native Texan,

MASON G. LOCKWOOD
Vice-President, Zone IV

There is still time to make plans for attending the ASCE Annual Convention, to be held in New York, October 19-23, with the Hotel Statler as headquarters (address requests for reservations to Mr. Albert G. Cox, Assistant Manager, Sales, Hotel Statler, Seventh Ave., and 32nd St., New York, N.Y.). Several of the Technical Divisions are cooperating in presenting various aspects of the major technical program theme, mass transportation. These and the other technical sessions (some thirty of them) are detailed in the full program in the September issue (page 60). An all-day tour to the Fairless Works of the U.S. Steel Corp., at Morrisville, Pa., is one of several interesting and unusual field trips on the agenda, which also includes an exceptional social program as well as such traditional Annual Convention features as the presentation of prizes and honorary memberships.

WILLIAM S. LA LONDE, JR.
Director, District 1

OLIVER W. HARTWELL
Director, District 4

THOMAS C. SHEDD
Director, District 8

SAMUEL B. MORRIS
Director, District 11

Mr. Lockwood was educated at Austin College and Rice Institute, from which he received the B.S. degree in electrical engineering in 1927. For eight years following his graduation he was with the Houston Lighting & Power Co. and its affiliates on construction work and as office engineer, handling special assignments and engineering investigations.

Since 1935 Mr. Lockwood has been in private practice—first as a member of the firm of Dowdell, Lockwood & Andrews, and later as a member of Lockwood & Andrews. With a wide practice in civil, structural, and industrial engineering, the firm has been closely identified with many important developments in the Gulf Coast region of Texas in recent years. During World War II it participated in the design and supervision of construction of a number of military establishments and defense industries. Mr. Lockwood was engineer-in-charge for the associated firms of Lockwood & Andrews and David M. Duller, Architect-Engineer for the design and supervision of construction of the $16,000,000 permanent ordnance depot and shipping terminal on the Houston Ship Channel known as the San Jacinto Ordnance Depot.

A member of ASCE since 1941, Mr. Lockwood is currently on the AIA-ASCE Cooperative Committee and on the ASCE Committee on Technical Sessions. His long service in the Texas Section includes terms as director, vice-president and currently as president. He is registered as a professional engineer in Texas in both the civil and electrical branches.

William S. La Londe, Jr.

William S. La Londe, Jr., Society Director for District 1, is chairman of the Department of Civil Engineering at Newark College of Engineering, Newark, N.J. A graduate of the Massachusetts Institute of Technology with an S.B. in C.E. and of the University of Michigan with an M.S. in C.E., he had early experience (for six years) in railroad and municipal engineering and construction work. He joined the Newark College of Engineering faculty as an assistant professor in 1929, advancing to professor and acting chairman of the civil engineering department in 1940.

Called to active duty in the Civil Engineer Corps of the Navy in 1941 with the rank of lieutenant commander, Professor La Londe served as a design officer and on staff duty until 1946.

A member of ASCE since 1937, Professor La Londe has long served the Metropolitan Section—on committees, as a director, and as president in 1950 and 1951. He was chairman of the Society's Annual Convention Committee for the first October Annual Meeting and New York Convention in 1951.

Oliver W. Hartwell

With the Water Resources Division of the U.S. Geological Survey since 1909, Oliver W. Hartwell, new ASCE Director for District 4, has filled various assignments for that agency. From 1909 to 1911 he was at Salt Lake City on stream gaging for water supply for irrigation projects; from 1911 to 1919, office engineer in charge of technical activities in the Albany, N.Y., office; and from 1919 to 1921, district engineer at Harrisburg, Pa., coordinating the stream-gaging program of the Pennsylvania State Water Supply Commission with that of the Survey.

As district engineer at Trenton, N.J., since 1921, Mr. Hartwell has coordinated the program of the office with that of the State of New Jersey. His work has included selection, design, and construction of the stream-gaging stations in the state, and he has supervised preparation of water supply statistics for publication in Survey papers.

Mr. Hartwell graduated from Harvard University in 1908, with the A.B. degree (magna cum laude) and was with the Massachusetts State Department of Health for two years before going to the Geological Survey.

A life member of ASCE, Mr. Hartwell has served the Philadelphia Section in many capacities, including chairmanship of the Program Committee for two years, director, vice-president, and president. He is now chairman of the General Committee for the ASCE Atlantic City Convention in June 1954.

Thomas C. Shedd

An engineering educator, Thomas C. Shedd, professor of structural engineering at the University of Illinois, Urbana, Ill., is Director-elect for District 8. He studied at the University of Virginia and Brown University, graduating from the latter in 1913 with the S.B. degree. In 1932 he received the degree of master of science in civil engineering from the University of Illinois. He had early experience as assistant and instructor at Brown University, and from 1918 to 1922 was designer and estimator for the Phoenix Bridge Co.

Joining the University of Illinois engineering faculty in 1922 as an associate in structural engineering, he was assistant professor of structural engineering from 1925 to 1930, and associate professor from 1930 to 1934. Since the latter year he has been full professor. He is author of *Structural Design in Steel* and co-author, with J. Vawter, of *Theory of Simple Structures* (John Wiley and Sons). Many summer vacations he has been with the Phoenix Bridge Co. and Waddell & Hardesty.

A member of ASCE since 1926, Professor Shedd was president of the Central Illinois Section in 1946. He has also been president of the Illinois Engineering Council. A member of the National Council of State Boards of Engineering Examiners, he was director from the Central Zone from 1949 to 1951.

Samuel B. Morris

Samuel B. Morris, new ASCE Director for District 11, is general manager of the Department of Water and Power of the

City of Los Angeles, serving a population of two million. Before taking this position in 1944 he had been dean of the School of Engineering at Stanford University since 1936 and executive head of civil engineering since 1935. He was born in Los Angeles and graduated from Stanford in 1911 in civil engineering. For 22 years he served the Pasadena Water Department as chief engineer and general manager. During the latter period, he built the Morris Dam dedicated in his honor by Herbert Hoover in 1934.

Mr. Morris has served as consulting engineer to several agencies of the United States and a number of cities and utility districts. He is a member of the Colorado River Board of California and was a member of the President's Water Resources Policy Commission in 1950–1951. He has also served as a member of the Committee on Geophysics and Geography of the Research and Development Board.

Active in ASCE since 1922, Mr. Morris has been president of both the Los Angeles and San Francisco Sections. He is also a past-president of the American Water Works Association and the American Public Power Association. In 1953 he was appointed by ASCE to serve on the EJC National Water Policy Panel.

Ernest W. Carlton

As a member of the engineering faculty of the Missouri School of Mines and professor of structural engineering in charge of graduate study, Ernest W. Carlton, Director-elect for District 14, has had opportunity for a wide range of experience in the field of civil engineering and construction. He is a graduate in mechanical engineering from Colorado Agricultural College and in civil engineering from the Missouri School of Mines. His early experience included work in the Fort Collins (Colo.) Engineering Department and with the Great Western Sugar Co. He also taught briefly at the University of Nebraska.

ERNEST W. CARLTON
Director, District 14

RAYMOND F. DAWSON
Director, District 15

He went to the Missouri School of Mines in 1920 and has continuously been on the faculty since then as assistant professor of drawing, associate professor of civil engineering, and (since 1936) professor of structural engineering. During World War II, Professor Carlton was War Training Administrator for E.S.M.W.T. at the School of Mines. He is the author of a textbook and numerous articles on various engineering subjects, and a frequent contributor to engineering and professional periodicals.

Professor Carlton became an Associate Member of ASCE in 1928 and a Member in 1936, and he is a past-president and former director of the Mid-Missouri Section. He has been Faculty Adviser of the ASCE Student Chapter at the Missouri School of Mines for the past 16 years.

Raymond F. Dawson

Raymond F. Dawson, new ASCE Director for District 15, is a specialist in the field of soil mechanics, widely recognized as an outstanding engineer on foundations. He recently served as official ASCE delegate to the Third International Conference on Soil Mechanics and Foundation Engineering in Zurich, Switzerland, where he gave a paper on "The Movement of Small Houses Erected on an Expansive Clay Soil." He holds the degrees of B.S. in C.E. from Purdue University and M.S. in C.E. from the University of Texas.

Before going to the University of Texas Professor Dawson worked for the Illinois State Highway Department and the U.S. Bureau of Public Roads for approximately five years. He was appointed testing engineer of the Bureau of Engineering Research at the university in 1938 and later became associate director of the Bureau and professor of civil engineering, which positions he still holds.

Professor Dawson began his soil mechanics research with laboratory tests and field investigations of settlement of the San Jacinto Battlefield Monument and some of the buildings of the Texas Centennial Exposition. He has worked assiduously on many other investigations since that time and has a number of projects underway at the present, which have made significant contributions to the profession. He is author of a laboratory manual on soil mechanics, published in 1949, which has been adopted as a text by 37 schools.

A member of ASCE since 1938, Professor Dawson has been active in the Texas Section, which he has served as vice-president.

Ladies Committee for Annual Convention

A good time for the ladies attending the forthcoming ASCE Annual Convention, to be held in New York, October 19–23, is being planned at this get-together of some of the members of the Ladies' Committee. Shown seated, left to right, are Mrs. W. S. Douglas; Mrs. W. S. La Londe, Jr., past chairman; Mrs. R. L. Brandes, chairman; Mrs. J. M. Garrelts, vice-chairman; Mrs. Don P. Reynolds; and Mrs. T. J. Fratar. Standing, in the same order, are Mrs. B. G. Johnson, Mrs. John R. Zehner, Mrs. Charles E. Trout, Mrs. S. D. Stickle, Mrs. R. H. Tatlow, III, and Mrs. J. F. Molloy.

International Hydraulics Convention in Minneapolis Proves Highly Informative

Both extensive and intensive study of current research and applied hydraulics programs was possible for those fortunate enough to attend the recent International Hydraulics Convention in Minneapolis. Under joint sponsorship of the ASCE Hydraulics Division and the International Association for Hydraulic Research, the convention attracted experts from 18 nations and from practically every one of the 48 states. The widely representative attendance made it especially interesting to witness the progression of the group through several days' (September 1–4) earnest discussion of subjects ranging from "Motion of Discrete Particles Along Bed of Turbulent Stream" to "Theoretical and Experimental Studies of the Propagation of Translation Waves in Open Channels," with language differences no apparent hindrance.

General topics covered were: Sediment Transportation; Density Currents; Waves, Beach Erosion and Shore Structures; and Air Entrainment by Flowing Water. Also featured was an open meeting of the ASCE Hydraulics Division Research Committee.

Unusual opportunity for profitable discussion at sessions of the convention was provided. All papers presented on the program had been brought together and published in a "Proceedings" which was available at the convention. Reference to CIVIL ENGINEERING for July, page 59, will provide information about speakers and their subjects. Copies of the proceedings are available upon request to: Dr. L. G. Straub, St. Anthony Falls Hydraulic Laboratory, Minneapolis 14, Minn. The price is $6.00 per copy plus 75 cents for packing and postage.

At Hydraulics Convention Banquet are (left to right): Prof. Miles S. Kersten, president of Northwestern Section; Director and Mrs. Lloyd D. Knapp; Dr. Wolmar Fellenius, of Sweden; and I.A.H.R. president L. G. Straub.

Caucus before convention banquet brings participants together: George E. Loughland (left), toastmaster, with ASCE Vice-President G. Brooks Earnest; Hydraulics Division Chairman Francis M. Bell; I. A. H. R. president Lorenz G. Straub; and Oliver G. Anderson, general chairman of arrangements.

Chief of Engineers Speaks

To the luncheon group, meeting at the close of the convention, Maj. Gen. Samuel D. Sturgis, Jr., Chief of Engineers, U. S. Army, discussed Army policy.

"The Corps of Engineers cannot and does not advocate any particular philosophy, or school of thought, in the field of resources development," he said, "other than the time-honored principle of obtaining maximum benefits at minimum cost while conforming to the general will of the people. It is immaterial to us whether this is accomplished by big dams or little dams, by upstream, downstream, or some other method or combination of methods of control."

Commenting on direction of policy, General Sturgis added, "The initiative for the development of our country's water resources does not lie with the Corps of Engineers. We are the servants of the people and execute their will as expressed through their representatives in Congress." At the present time, he said, the Corps of Engineers has "funds for 81 projects in 35 states."

Representing the ASCE Board at the convention were Vice-President G. Brooks Earnest, Directors Lloyd D. Knapp and Francis M. Dawson. Chairman Francis M. Bell, of the Hydraulics Division, had his complete executive committee on hand, as well as members of the Division's Research Committee. Arrangements for the convention were carried out under the general direction of Dr. Lorenz G. Straub, M. ASCE, president of I.A.H.R., by a Northwestern Section committee under the chairmanship of Prof. Oliver G. Anderson.

Engineering Societies Building Outgrown

For a number of years now the physical facilities of the Engineering Societies Building in New York City have been inadequate. Constructed almost half a century ago as the official home of the engineering profession in the United States, the building no longer satisfies the needs of either the professional groups now using it or the needs of similar engineering groups that have indicated a desire to be housed in an Engineering Societies Building. The original building was made possible through a direct gift from Andrew Carnegie of a million and a half dollars in 1904. Out of it grew the present 16-story Engineering Societies Building at 33 West 39th Street.

Although the Engineering Societies Building was constructed in 1906, it was not until 1917 that the American Society of Civil Engineers moved from its own home at 220 West 57th Street to share the building with the AIME, ASME, and AIEE. ASCE built and paid for the construction of the two top floors, which it now occupies, in the building. The building and land on 57th Street still remain the property of the Society.

The Engineering Societies Building contains a gross floor area of about 118,000 sq ft. Of this area 23,600 sq ft is unrentable space, of which 14,000 sq ft is occupied by the Engineering Societies Library. The large auditorium, which is rentable but seldom used now by the societies themselves, uses 18,000 sq ft. Several associate societies occupy space in the building on a rental basis—among them the American Institute of Consulting Engineers, the American Rocket Society, the Society of Automotive Engineers, the American Welding Society, and the Society of Naval Architects and Marine Engineers.

The current building and ground are owned in equal parts by the four Founder Societies, ASCE, AIME, ASME and AIEE. Each of these Societies has three representatives on the board of trustees of United Engineering Trustees, Inc., the titular owner and operator of the building. The obsolescence of the present structure and its lack of capacity to continue to perform its original function have led UET to investigate the possibility of acquiring a building for a new and adequate national engineering societies center. This investigation has been carried on actively during the past three years and appears presently to be reaching a point where a decision must be reached.

Estimates by UET indicate that a new building of modern construction with about 200,000 sq ft gross floor space would be adequate to meet the needs for a national engineering societies center. A rough estimate for the construction and land for such a building in New York City is in the neighborhood of $6,000,000, of which $1,000,000 or $1,250,000 is estimated as the probable cost of the land.

The Building Committee of UET has gone on the assumption that the new engineering center need not necessarily be built in New York City. It has assumed that if compelling reasons, financial or otherwise, could be found for locating the building in some other suitable city, the trustees of UET and the boards of direction of the four owner Societies probably would concur in locating elsewhere.

Active inquiries in the last year or two have developed interest in several quarters outside New York City. A private firm, one of whose partners is a member of ASCE, has offered to donate an adequate site in Washington, D.C. Engineering and business interests in Pittsburgh, Pa., also have made available a substantial sum of money to UET as an inducement for constructing the building in that city. Interests in Chicago have indicated a desire to have the national engineering center constructed there.

These proposals from Washington, Pittsburgh, and Chicago, as well as possibilities in New York City are currently before the Real Estate Committee of UET for study. That Committee will weigh the pros and cons of all the proposals, particularly the financial pros, and make a definite recommendation to UET some time within the next month or two. If UET approves the recommendations of its Real Estate Committee, it will transmit the proposal for decision by the governing bodies of each of the four Founder Societies. This procedure will take time, as will the necessary procedures for design and construction of the new building. There are certain to be many differences of opinion expressed on all phases of the project. Since the question of financing by each is certain to receive deliberate consideration, it seems unlikely that the new building, wherever located, could be in readiness for use in much less than three years time after UET has made its recommendation to the owner societies.

Tellers Canvass Ballot for 1954 ASCE Officers

September 15, 1953

To the 1953 Annual Meeting
American Society of Civil Engineers:

The Tellers appointed to count the Election Ballots for Officers of the Society for 1954 report as follows:

For President
(Term October 1953–October 1954)

Daniel Voiers Terrell	10,423
Scattering	31
Void	7

For Vice-President—Zone I
(Term October 1953–October 1955)

Enoch R. Needles	1,883
Scattering	12
Void	0

For Vice-President—Zone IV
(Term October 1953–October 1955)

Mason G. Lockwood	3,154
Scattering	7
Void	8

For Director—District 1
(Term October 1953–October 1956)

William S. LaLonde, Jr.	1,071
Scattering	10
Void	0

For Director—District 4
(Term October 1953–October 1956)

Oliver W. Hartwell	480
Scattering	2
Void	0

For Director—District 8
(Term October 1953–October 1956)

Thomas C. Shedd	671
Scattering	4
Void	1

For Director—District 11
(Term October 1953–October 1956)

Samuel B. Morris	1,841
Scattering	5
Void	3

For Director—District 14
(Term October 1953–October 1956)

Ernest W. Carlton	548
Scattering	5
Void	0

For Director—District 15
(Term October 1953–October 1956)

Raymond F. Dawson	911
Scattering	7
Void	1
Ballots counted	21,085
Ballot envelopes rejected:	
Without signature	175

Respectfully submitted,

Robert E. White, *Chairman*
Edward L. Winslow, *Vice-Chairman*
Victor Feigelman — William J. McGraw
Joel E. Fisher, Jr. — Edwin D. Silvers
Herbert M. Mandel — Paul M. Wentworth
(*Tellers*)

Contract Form Issued as Construction Guide

Publication of a suggested contract form for use as a guide in the preparation of contracts for private engineering construction projects is announced by ASCE and the Associated General Contractors of America. Drafted by a Joint Cooperative Committee of the two organizations, the document replaces an older form that had been unchanged since 1925. The 15-page document, regarded by the committee as one of its most important projects since its organization in 1948, covers the contract agreement itself, with the three alternative bases of payment to the contractor (lump sum, unit price, and cost-plus), and the general conditions of the contract.

Designated ASCE Form JCC-1 and AGC Standard Form 3, the publication is available from ASCE, 33 West 39th Street, New York 18, N.Y., or AGC, Munsey Building, Washington 4, D.C. The price is 25 cents a copy, $2.75 for twelve copies, and $20 for 100 copies.

Present co-chairmen of the Joint Cooperative Committee are Past-President Gail A. Hathaway for ASCE and Dwight W. Winkelman for AGC.

J. Waldo Smith Hydraulic Fellowship Is Awarded

Robert E. Templeton, J.M. ASCE, who graduated in June from Carnegie Institute of Technology with the degree of bachelor of science in civil engineering, has been awarded the J. Waldo Smith Hydraulic Fellowship for 1953–1954. Mr. Templeton served as secretary of the Carnegie Institute Student Chapter and, by unanimous recommendation of the civil engineering faculty, received the Pittsburgh Section's prize of Junior Membership awarded the outstanding civil engineering senior. This year, under the terms of the fellowship, he will undertake a study of "Scale Relationships for Air Entrainment" as a graduate student in civil engineering at Carnegie Institute.

The J. Waldo Smith Hydraulic Fellowship was established by the Board of Direction in 1938 with funds bequeathed by the late J. Waldo Smith, Hon. M. ASCE. It runs for a full year and provides $1,000 plus as much more up to $400 as may be required for physical equipment connected with the research.

Guidance Work of Los Angeles Engineering Council Lauded

The value and effectiveness of energetic and well coordinated local career guidance has been brought to the attention of the Engineering Manpower Commission of EJC by reports of engineering guidance and career development activity in various parts of the country. Such a guidance program, hailed by the Commission as "one of the most carefully planned and comprehensive we have seen," is that of the Los Angeles Engineering Council, which is reported by Finley B. Laverty, M. ASCE, until recently chairman of the Council.

Carried out annually with the full cooperation of the high school officials, principals, and counselors in the Los Angeles area, the program consists of meetings in various high schools in the Los Angeles school system. The meetings are attended, for the most part, by students who have demonstrated unusual competence in science and mathematics. Parents are also invited to the meetings by personal letter from the high school principal. The programs consist of brief introductory talks of a general nature followed by consultation between parent and student and outstanding men from the various fields of engineering. Appropriate press releases are provided prior to the meetings. In 1952 more than 2,200 students attended such meetings with their parents.

New Activities Undertaken by Irrigation and Drainage Division

Expansion of publications and meeting programs was planned by the Executive Committee of the Irrigation and Drainage Division in the course of a recent meeting in Denver. Two new manuals in preparation were the subject of reports. The first of these covers practice of subsurface drainage in irrigated lands; the second will make available extensive new information on ground-water storage. Availability at an early date for review is anticipated. To administer the Division's program in the preparation of materials for publication, a Division publications committee was organized.

Geography has been a problem to the Division in attempts to arrange sessions of current interest for its members in their field of special interest. Since no major Convention of ASCE is scheduled to take place in the West for several years to come, the Division has made plans for a Committee on Sessions Programs which will conduct such meetings as a service to engineers working in irrigation and drainage. The drainage aspect will be developed by the new Division Committee on Irrigation and Drainage Practice in Humid Areas.

At the meeting Walter E. Blomgren was named incoming chairman of the Division.

Committee chairmen of Irrigation and Drainage Division join Division's executive committee at meeting in Denver. Shown seated, in usual order, are: D. P. Reynolds; W. E. Blomgren, incoming Division chairman; and G. S. Knapp, retiring Division chairman. Standing, left to right, are: I. B. Hosig, F. W. Slattery, A. P. Rollins, H. F. Blaney, G. N. Carter, and H. O. Banks.

FROM THE NATION'S CAPITAL

JOSEPH H. EHLERS, M. ASCE — Field Representative ASCE

The general summer letdown in governmental activity in the Washington area following the departure of the legislators affords an opportunity to take stock of the whirlwind shifts since the Society's last annual convention—the Centennial in Chicago. A year ago much ASCE oratory centered on the hope for a new economic and governmental approach to usher in our second century. It has arrived.

A year ago the engineering profession and the whole construction industry were tied up in a maze of controls and restrictions. This office worked closely and effectively with the overall construction industry groups, such as the Construction Industry Advisory Council sponsored by the U. S. Chamber of Commerce and now under the chairmanship of Ezra Whitman, ASCE Past-President. Controls have fallen with a resounding thud and the free economy is here, modified simply by a priority system for critical metals for direct defense construction. A new emphasis has been placed on non-military construction, on highways, bridges, and office buildings. Even though the economy-drive cut-offs have slowed up some federal work, 1953 gives promise of being the greatest construction year of all time with a possible total approaching $35 billion. Very probably 1954 will mark a leveling-off period.

Reorganization and Plans for the Future

Ten major reorganization plans have gone into effect involving the creation of some new agencies and the abolition of others. (See the June 1953 issue of CIVIL ENGINEERING, page 70.) Commissions to deal with further reorganization were mentioned in this column last month. A new Advisory Committee on Housing has just been named to review the government's interest in that vast and complex field.

In addition to the official commissions, the Mid-Century Conference on Resources for the Future must also be mentioned. This is a private enterprise under the general sponsorship of the Ford Foundation carrying the unofficial blessing of the government. This effort formerly seemed to be directed toward some hastily considered objectives, and the conference was scheduled for last May. This office joined with several business and professional groups in urging a postponement and a review of the proposed operations. The postponement to December 1953 has given professional groups such as EJC a chance to devote more attention to the objectives and proposed procedures, as well as to place some outstanding engineers on key committees.

Legislative and Executive Department Actions

Current developments were reviewed in this column last month. The lack of action on the Taft-Hartley Law, especially in respect to professional workers, should be emphasized. The matter will arise again and require attention. EJC appeared before House and Senate Committees to argue against changes in the professional provisions and is continuing its watchfulness. Legislation for providing tax-favored retirement funds for self-employed professionals advanced from a very unimpressive request to a much sounder proposal which is receiving serious consideration.

The renegotiation of government contracts was a source of great concern a year ago. No serious problems seem to have arisen under a sound and fair administration of the program by the Renegotiation Board and its staff.

The status of engineers and engineering as a profession has improved since the passage of the law exempting engineers from salary controls on a par with other professional men. Despite much talk among engineers to the contrary, the popular concept of the engineer is not as the man who runs the locomotive but rather as the man who harnesses the atom. Engineering is known as a favored profession among high school students and seems to be gaining in prestige. The weakest point in public relations in the engineering profession is not with the public but internally within the profession.

Foreign Aid

The whole concept of foreign aid seems to be changing from a world-relief philosophy to a "Trade Rather Than Aid" idea. The former concept that direct assistance in relieving poverty would keep away Communism has given way to a more realistic recognition of international political relations. An emphasis on providing means for an under-developed country to enter into world markets to an increased extent should lead to a greater appreciation of engineering development.

The newly authorized Korean rehabilitation program is a special situation and will probably become an important aspect of the Foreign Aid Program.

Power Development

Considerable change has taken place in governmental views on power development. Started off by the Supreme Court decision in the Roanoke Rapids case (Civil Engineering for April 1953, page 70), the legislative and executive departments have followed with further deemphasizing of public power development culminating in a recent statement by the Interior Department.

The St. Lawrence Waterway did not receive Congressional approval and will continue to be debated in Congress. Power development at Niagara Falls is also unsettled with private companies contending with the state of New York for the key position.

Washington, D.C.
September 18, 1953

ASCE MEMBERSHIP AS OF SEPTEMBER 9, 1953

Members	8,455
Associate Members	10,799
Junior Members	17,445
Affiliates	69
Honorary Members	40
Total	36,808
(September 9, 1952	35,538)

New Society Jewelry Available

For members who wish to display the ASCE emblem, the Society has made available a tie clasp mounting an ASCE shield similar to its small lapel button. The clasp with emblem is gold plated and may be purchased for $4.17, plus 20 percent federal tax, or a total of $5. The 20 percent tax is not payable on export orders. Also available to members is a watch charm emblem attached to a gold-plated tie chain, which may be purchased for $8.33 plus 20 percent for federal tax, making a total of $10. As with the tie clasp, the tax is not payable on export orders. These emblems are available for Members, Associate Members, and Affiliates.

Junior Member shields are available in the standard types only. At present there are no tie clasp or tie chain emblems for Junior Members. An order coupon is given on page 86 for the convenience of those wishing to purchase any of the ASCE emblems.

EUSEC Congress Held in Paris

Delegates representing seventeen national engineering societies in twelve countries attended the fourth biennial meeting of EUSEC (Europe-United States Engineering Congress) held in Paris, September 7–11, with the Société des Ingénieurs Civils de France as host. The meeting was the first full-fledged EUSEC Congress since a meeting in The Hague two years ago. ASCE was represented in Paris by President Walter L. Huber and Secretary W. N. Carey. The American Society of Mechanical Engineers was represented by Secretary C. E. Davies, and the American Society of Electrical Engineers by its president, E. B. Robertson, and Secretary H. H. Henline.

Other engineering societies sending delegates were the Verein Deutscher Ingenieure, Germany; Société Royale Belge des Ingénieurs et des Industriels, Belgium; Dansk Ingeniorforening, Denmark; Joint Council of Suomalaisten Teknikkojen Seura and Tekniska Föreningen i Finland, Finland; Société des Ingénieurs Civils de France, France; the Institution of Civil Engineers, the Institution of Mechanical Engineers, and the Institution of Electrical Engineers, Great Britain; Koninklijk Instituut van Ingenieurs, Holland; Associazone Nazionale Ingegneri ed Architetti Italiani, Italy; Norske Ingeniorforening, Norway; Svenska Teknologföreningen, Sweden; and Société Suisse des Ingénieurs et des Architectes, Switzerland.

Actions taken included discussion of the possibility of creating professional codes of ethics; ways of improving the semiannual bulletin established by EUSEC after the Hague Conference; and the result of efforts to obtain the close cooperation of EUSEC with such similar international groups as the Conference of Engineering Institutions of the British Commonwealth and the Conference of Engineering Societies of the Western Hemisphere (UPADI).

ASCE Honorary Member Sherman Woodward Dies

Sherman Melville Woodward, ASCE Honorary Member and authority in the field of hydraulics, died in Knoxville, Tenn., on September 7, at the age of 82. A consulting engineer to the Tennessee Valley Authority from 1934 until his death, Mr. Woodward received wide recognition for his work on this project. For several years he also held the post of chief water control planning engineer in charge of the utilization and control of the flow in the Tennessee River.

Sherman M. Woodward

At the time he joined the TVA in 1934, Mr. Woodward had 36 years of experience as a teacher of engineering behind him—as professor of mechanics and physics at the University of Arizona (1896–1904) and professor of mechanics and hydraulics at the University of Iowa (1904–1905, 1908–1934). As a consulting engineer for the Miami Conservancy District at Dayton, Ohio, Mr. Woodward was responsible for the fundamental hydraulics of the project and wrote reports on the results of his work there that are considered notable contributions to hydraulic engineering literature. He was also consultant to the U. S. Bureau of Standards on design of the National Hydraulic Laboratory and to numerous other agencies. He was a graduate of Washington University and Harvard University. A long-time member of ASCE, he was elected Honorary Member in 1943.

Local Section Newsletters Growing in Number and Importance

Keeping abreast of the times, more and more ASCE Sections are publishing newsletters. Within the past year, six have been added to the list making a total of 27, or about 35 per cent of the Society's 77 Sections. These range in size from the more ambitious publications of the Texas and Tennessee Valley Sections to the simple, yet effective mimeographed letters published by the smaller Sections. Latest to enter the field are the Oregon, New Mexico and Kentucky Sections, and a Metropolitan Section Newsletter is scheduled for appearance this fall. The relatively new Alaska Section is now publishing a newsletter which serves to unite its farflung membership distributed over an area roughly a fifth the size of the United States.

Regardless of size, the editorial pattern of the newsletters does not vary greatly. News of coming meetings and reports of past meetings are usually included, some of the Sections even publishing papers presented at their meetings. Likewise, personal items about Section members are commonly included in the publication. Many of the Sections also feature a column by the Section president on items of current professional importance to the profession in that locale and an editorial. The other items found in the Local Section publications vary, depending on the extent of the Section's activities. Thus many include reports on Local Section Technical Division activity, Junior Forum meetings and field trips, and Student Chapter affairs.

The principal quality of successful publications is the service they provide for ASCE members in a particular locality. This may be in the form of items of interest to the professionally minded engineer that would not otherwise reach him through existing media. It may be in the form of personal information about the activities of acquaintances, or important news of technical developments in the area.

Of the 27 Section publications four are published jointly by all the Founder Society sections or in Technical Council bulletins. These have the advantage of informing the Section membership of technical activities outside the field of civil engineering though not necessarily unrelated to it. Of course in a joint venture of this sort, the Section gets less space for its own use than would be available in a newsletter of its own.

Most of the newsletters are supported by Sections funds without the aid of advertising income. Eight of the more expensive publications—coated paper with special covers, etc.—do depend, at least in part, on advertising revenues. The ads generally are for services available to engineers or for equipment and material dealers serving engineers in the area.

However, advertising is not the sole source of income offsetting the cost of the newsletter. Experience has shown that

the interest generated by such a Section activity generally results in greater attendance at meetings and subsequent increased dues collection. An outstanding example of the growth that follows publication of a Section newsletter is the attendance at Florida Section meetings. When the Section began publication of a newsletter in 1944, it had a total member attendance of 83. By 1947 the total member attendance had reached 385.

In 1948 the secretary of the Sacramento Section attributed the high ratio of dues-paying members of the Section (88.3 percent) to the success of its four-page newsletter. At the recent Local Section Conference at Miami Beach, C. E. Drummond reported that, "The major portion of the 100 percent growth which the Georgia Section has enjoyed in five years has occurred in the last two years since the start of this (*Civil Engineering in Georgia*) publication."

To judge from the membership response in the Sections publishing newsletters, they are well received. There is no more accurate barometer of the value of Section activity, than the amount of member participation in Section programs and projects.

Charles I. Suplee and Mrs. Suplee, Robert M. Dodds, and Fred A. Richards are part of large group of Pittsburgh Section members making an Ohio River inspection trip as guests of the Dravo Corporation on its boat "Freedom." The all-day trip included inspection of Dravo's plant employing the heavy media separation process for gravel.

NOTES FROM THE LOCAL SECTIONS

(Copy for these columns must be received by the tenth of the month preceding date of publication.)

The agenda for the August meeting of the **Duluth Section** included discussion of the advisability of forming a branch for the benefit of Section members in the Iron Range area. A survey of the opinion of the Section membership will be reported at the September meeting. A talk on the problem of weed control on railroad right of ways to provide weed-free trackage and effective firebreaks—given by W. R. Lawrie, supervisor of fire protection for the D.M. & I.R. Railroad—constituted the technical program.

Golf, swimming, and a horseshoe pitching contest were the order of the day at the **Georgia Section's** annual summer outing. About 90 members and their families enjoyed the various sports which were followed by a picnic dinner and evening of dancing. C. E. Drummond, Jr., was program chairman.

The **Illinois Section** is cooperating with other engineering groups in the Chicago area in sponsoring "a basic program" of seven courses offered in cooperation with the University of Illinois, Division of University Extension. The program was prepared as the result of a survey of industrial leaders in the area, which revealed "outstanding deficiencies in engineers in their employ." The program offers four general interest and three professional engineer refresher courses.

A committee of **Michigan Section** members, headed by Edwin C. Miller, has been studying the Section's constitution during the past year with the objective of bringing it up to date. After much study and a conference with the Section directors, the committee decided that the constitution should be entirely rewritten to conform with present-day situations such as the need to work with the Michigan State Registration Board on the registration of engineers.

A panel discussion on tilt-up precast concrete construction was a major feature of the **Mid-South Section's** two-day fall meeting held in Memphis, September 11 and 12. Taking part were Frank T. Tobey, Jr., consulting engineer; George Wible, of the S & W Construction Co.; Alfred Bowman, of the Fisher Steel Corp.; and Henry Dougherty, of the Portland Cement Association. L. T. Sumner was moderator. Also of interest was a symposium on plans for local parkway improvement given by City Engineer William B. Fowler and his staff. Other features of the two-day program were a Friday luncheon, addressed by ASCE Vice-President G. Brooks Earnest; a dinner dance Friday evening; and a tour on Saturday of the recently completed Thomas H. Allen Pumping Station conducted by the Memphis Light, Gas & Water Division.

Four one-hour luncheon meetings, arranged by a group of Junior Members headed by John J. Cusack, were enjoyed by the **Northeastern Section** during the summer. Attendance at the meetings, consisting of a summertime luncheon at the Boston City Club and 20-minute talks, ranged from 60 to 125. The speakers were Prof. Ernest L. Spencer, of Northeastern Uni-

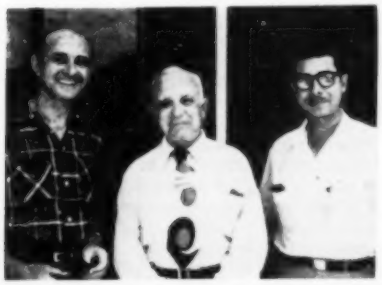
Navy civil engineers in San Francisco area bid bon voyage and smooth sailing to Rear Admiral Cushing Phillips, M. ASCE, CEC, USN, on eve of his retirement from 33 years active naval service. Pictured in usual order at recent San Francisco Section dinner in his honor are Lt. Comdr. George A. Brelie, CEC, USNR; Rear Admiral Carl A. Trexel, CEC, USN (ret.); Rear Admiral Phillips; Capt. Charles M. Herd, CEC, USNR; and Lt. Comdr. Lauress L. Wise, CEC, USNR. Long active in the San Francisco Section, Admiral Phillips represents the Section on the EJC Education Committee.

versity, with the subject, "The Abrasion Testing of Concrete"; Prof. A. G. H. Dietz, of Massachusetts Institute of Technology, who discussed observed structural failures in housing as affected by the Worcester tornado; Robert Blumenthal, J. M. ASCE, who read his prize-winning paper in the General Motors Highway Contest; and John A. Volpe, Massachusetts Commissioner of Public Works, who outlined the highway work in the state.

Ralph Carlisle Smith, assistant director for classification and security of the Los Alamos Scientific Laboratories, spoke on the organization and purpose of the laboratories at a recent dinner meeting of the **New Mexico Section** held in Los Alamos. Colored movies of two atomic explosions concluded the program. President and Mrs. Walter Huber, of San Francisco, were guests of the Section.

Explorations for Oroville Dam were discussed at the **Sacramento Section's** August 11 luncheon meeting by Elmer Marliave, supervising geologist with the California Division of Water Resources. The dam, which is a key feature of the Feather River project, will be more than 700 ft high and will impound 3,500,000 acre-ft of water. Other recent luncheon meeting speakers were Irvin Ingerson, associate hydraulic engineer for the Division of Water Resources, whose subject was "The Engineer and the Attorney in Trial," and Harold C. Green, who in a talk on "Engineered Foundations," warned that foundation engineers must ever be on the alert for trouble, since "soil deposits are quite variable and more difficult to analyze than most construction materials."

The annual summer meeting of the **South Carolina Section**—held at the Cleveland Hotel in Spartanburg, July 24-25—was a joint session with the South Carolina Society of Engineers. The program consisted of a business meeting, inspection trips, a banquet, and barbecue.



Members of Houston Branch of Texas Section visit Lake Houston for inspection of San Jacinto River Dam, canal and purification plant, now under construction. Project will serve as supplementary domestic and industrial supply for the area. Pictured are Al Bahn, Jr., president, Houston Branch; Walter E. Dickerson, Section director for Houston Branch; and José J. Correa, J. M. ASCE, and consul of Nicaragua in Houston.

Enoch R. Needles (seated center), New York City consultant and ASCE Vice-President-elect, is principal speaker at the anniversary meeting of the Maine Section, held at Hallowell, Me., on August 7. Shown with him are Carl Crane (left), president of Maine Association of Engineers, and Prof. C. B. Breed. Standing, in same order, are ASCE Director Frank A. Marston; Neal D. McDowell, past-president of Maine Section who presided in place of President Weston Evans; and Andrew G. Bisset, representative of the Section's New Hampshire Branch. Speaking on the expansion of turnpikes since the end of the war, Mr. Needles noted that Maine was a pioneer in the field with the completion in 1946 of a 45-mile toll road from Kittery to Portland. Construction of a 65-mile extension of the road to Augusta will be started this fall by the Maine Turnpike Authority, Mr. Needles told the group of 50 members and guests.

Coming Events

Akron—Dinner meeting at the Akron Liedertafel, on October 22, at 6:30 p.m.

Arizona—Arizona Fifth Joint Annual Meeting of all national engineering societies in the state scheduled for the Hotels Westward Ho and Adams, in Phoenix, November 6 and 7. Joint banquet at the Hotel Westward Ho, November 6, and business meetings and luncheons at the Hotel Adams, November 7. A dinner dance will close the sessions.

Central Ohio—Dinner meeting at the Ohio Union Building, Ohio State University campus, on October 22, at 6:30 p.m.

Los Angeles—Annual ladies night will be held at Ciro's in Hollywood, on November 6. Meeting at the Rodger Young Auditorium, 936 W. Washington Boulevard, Los Angeles, on October 14, at 7 p.m. Junior Forum meeting at the Rodger Young Auditorium, October 14, 5:45 p.m.

New Mexico—Fall meeting in Albuquerque, N. Mex., October 24, to include trip to Jemez Dam and the Santa Ana Protection Works.

Northeastern—Annual student night to be held jointly with the Boston Society of Civil Engineers at Tufts College, Medford, Mass., on October 14.

Sacramento—Weekly luncheon meetings at the Elks Temple every Tuesday at 12 noon.

Tennessee Valley—Annual fall meeting at Knoxville, Tenn., November 13 and 14.

Texas—Fall meeting at the White Plaza Hotel, San Antonio, Tex., October 15 and 16, preceded by a meeting of the Board on the 14th.

Virginia—Annual joint fall meeting with the Engineers Club of Hampton Roads at the Norfolk Yacht and Country Club, Norfolk, Va., November 24.

West Virginia—All-day annual meeting at the Daniel Boone Hotel in Charleston, W. Va., October 9. President-elect Terrell will speak.

Scheduled ASCE Conventions

NEW YORK CONVENTION
Hotel Statler
October 19-23
1953

ATLANTA CONVENTION
Atlanta, Ga.
Hotel Biltmore
February 15-19, 1954

ATLANTIC CITY CONVENTION
Atlantic City, N.J.
Chalfonte-Haddon Hall
June 14-19, 1954

NEWS BRIEFS . . .

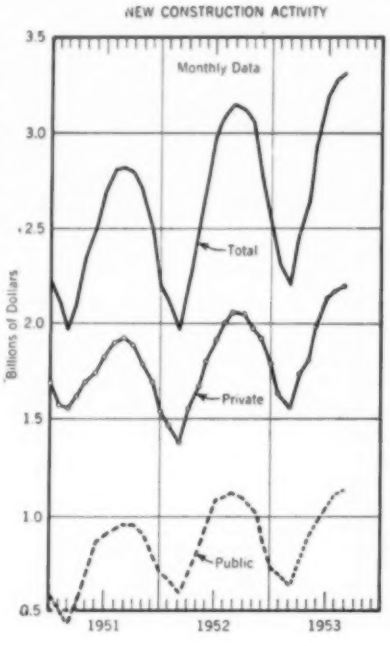
August Construction Maintains Record Levels

Expenditures for new construction continued at record levels in August, totaling slightly over $3.3 billion, according to preliminary estimates of the Building Materials Division of the U.S. Department of Commerce and the U.S. Labor Department's Bureau of Labor Statistics. Private expenditures totaled $2.2 billion, and public expenditures, $1.1 billion. Both amounts were slightly above the July totals, and the dollar volume was about 7 percent above the total for August 1952.

The July-August increase, however, was somewhat less than expected for the time of year, largely because of a drop in private housing. Dollar outlays for private residential construction declined for the second successive time in August, reflecting a downtrend in housing starts during the preceding three months.

Commercial building, continuing the sharp upward movement of the past several months, rose considerably more than seasonally. Private spending on industrial building leveled off, after a steady decline since early spring. Gains in roadbuilding and in privately owned public utilities were about seasonal. Expenditures for military and naval facilities and for public industrial plant remained unchanged from July.

The August figures probably slightly overstate the value of work actually put in place during the month, however, because estimating techniques currently in use do not take into account the full effects of work stoppages. In recent weeks, strike-associated idleness among construction workers has been unusually extensive in several parts of the country, especially in the New York City area where a truckers' strike has interrupted work on numerous construction projects.



Construction expenditures, totaling slightly over $3.3 billion, maintain record levels for the month, as shown in Department of Commerce curves.

For the first eight months of the year, new construction expenditures totaled nearly $22.7 billion, about 8 percent above the amount for the same period in 1952. Physical volume (expenditures adjusted for price changes) also was up moderately from last year. Despite the declines of the past two months, dollar outlays for new private residential building thus far in 1953—at $7.7 billion—were 9 percent above the level of a year ago, and almost equaled the January-August peak in 1950. Commercial building (at $1.1 billion) exceeded last year's total by over 50 percent, while private industrial building (at $1.5 billion) was slightly under the 1952 amount. The $2.8 billion spent by private firms for construction of public utilities this year represented a new record for the January-August period, and was 10 percent above expenditures last year. Private spending for all types of new construction amounted to $15.3 billion in the first eight months this year—9 percent more than in the corresponding months of 1952.

Total public outlays of $7.4 billion for new construction were 6 percent above the year-ago total in the January-August period, mostly because of increases for industrial plant (including atomic energy facilities) and for highways. Road-construction expenditures during the first eight months of 1953 totaled an all-time high of $1.9 billion. Expenditures for military and naval facilities and for school construction were somewhat greater than in 1952, but outlays for public residential building and hospital construction were down substantially.

Los Angeles Completes New Water Supply Facilities

Completion of a major connection between the Los Angeles water system and the Colorado River Aqueduct supply lines of the Metropolitan Water District has been marked by turning Colorado River water into the new 85,000,000-gal Eagle Rock Reservoir and a six-mile section of the 68-in.-dia Eagle Rock–Hollywood conduit. The facilities were built under contract by the Los Angeles Department of Water and Power, of which Samuel B. Morris, M. ASCE, is general manager and chief engineer and Burton S. Grant, M. ASCE, is chief engineer of water works.

Designed to regulate the flow of water from the Colorado River feeder lines into the city's distribution system, the reservoir and appurtenant tunnels were completed at a contract price of $1,380,702 by the Kemper Construction Co., after Department forces had completed preparation of the site and preliminary construction. Work on the reservoir began in 1950, and the first section of pipeline was started in 1952.

Oil Pipeline Is Laid Under Mackinac Straits

Recent laying of twin oil pipelines under the Straits of Mackinac completes one of the most difficult pieces of construction in oil pipeline history. The pipeline crossing, the deepest ever made, was handled by the Merritt-Chapman & Scott Corp., under the supervision of the Bechtel Corp., coordinator of the project. The Straits are 240 ft deep at some points, and known for their treacherous currents.

The two 20-in. tubes, crossing the four-mile Straits between St. Ignace and Mackinaw City are part of a 635-mile, 30-in.-dia extension of a pipeline being built by the Interprovincial Pipeline Co. and its American subsidiary, the Lakehead Pipeline Co. The twin 20-in. lines of the crossing join the 30-in. line each side of the Straits. The combined pipeline system, which will have a total length of 1,765 miles, will extend from Edmonton, Alta., across Minnesota, Wisconsin, and Michigan to the United States–Canadian border near Sarnia, Ont., at the southern tip of Lake Huron.

Scheduled for completion by December 1, the Lakehead Company's extension will permit transportation of crude oil from the vicinity of Edmonton to various Great Lakes ports. At present the oil pipeline extends only to the head of the Great Lakes, where the oil is reshipped by tankers to various Great Lakes ports.

Contract Given for New Hoboken Pier

Award of a $4,393,200 contract for construction of Pier C at the Hoboken–Port of New York Authority piers—the first major improvement in the Port Authority's $22,000,000 Hoboken pier program and the first new pier to be built in Hoboken in 25 years—has been authorized by the Port Authority. The contract award goes to the low bidder, J. Rich Steers, Inc., of New York City.

The steel and concrete "finger" pier of modern design, which will replace three piers destroyed by fire, will provide a berth on either side with a total of more than 180,000 sq ft of cargo space. It will be 700 ft long and 328 ft wide, the widest in the Port of New York, and will have two 500-ft-long depressed railroad tracks through the center. A third railroad track, 680 ft long, will be built on the north apron of the pier for handling cargo direct from vessels. Completion is expected by the spring of 1955, a year in advance of the commitment under the Port Authority's 50-year lease. The pier was designed by Parsons, Brinckerhoff, Hall & Macdonald, consulting engineers of New York.

Link Between Turnpike and Holland Tunnel Planned

A $100,000,000 extension of the New Jersey Turnpike, which will connect the Newark Airport Interchange with the Holland Tunnel, is planned by the New Jersey Turnpike Authority. Though arrangements for financing have not been completed, it is expected that the 8.5-mile elevated road through congested metropolitan New Jersey will be ready for use in the summer of 1955. The entire project will be self-supporting through the charging of reasonable tolls, with from 20 to 23 years required to pay off the estimated cost, according to Paul L. Troast, chairman of the New Jersey Turnpike Authority.

Present plans call for a $40,000,000,000 high-level bridge over Newark Bay, which has received Army Corps of Engineers clearance. The six-lane expressway will have three interchanges in Jersey City and Bayonne to accommodate local traffic. To expedite cross-county traffic there will be a marginal road freeway, to be constructed in cooperation with the New Jersey Highway Department along the right of way of the turnpike extension as it crosses the Bayonne Peninsula.

The projected extension, which was approved by the legislature in June 1952, is one of four major extensions that the Turnpike Authority expects to construct in the next three years. The others are the highway and bridge connecting the turnpike with the Pennsylvania Turnpike, the Essex County cross-county parkway; and an extension of the turnpike from its present terminus near the George Washington Bridge to the Rockland County line, where it will meet a proposed spur of the New York State Thruway.

Garden State Parkway to Span Raritan River

Work is going ahead on the Raritan River Bridge, which will be the largest structure on the Garden State Parkway now under construction by the New Jersey Highway Authority between Cape May and Paramus (in Bergen County), N.J. Crossing the Raritan River parallel to and 175 ft west of the existing Edison Bridge, the new span will connect the Borough of Sayreville on the south with Woodbridge Township on the north. It will be a high-level fixed structure with two roadways each 30 ft wide, two 2-ft walkways, and a central 5-ft mall separating northbound and southbound traffic. It is designed for H-20 loading.

The bridge consists of eight simple girder spans of 132.5 ft, on the south; two units of three continuous girder spans, each 200 ft in length; one unit of three continuous girder spans, 200, 250, and 200 ft in length; and (on the north) of six simple girder spans of 152.5 ft and six simple girder spans of 84.5 ft. The continuous spans are over the river, with the 250-ft span above the main river channel to provide 200-ft horizontal clearance and a vertical clearance of 135 ft. The 152.5- and 84.5-ft spans are on horizontal curve. Depth of the 152.5-ft simple span girder and of the continuous girders is 12 ft 6 in., except over the piers of the 250-ft spans where it is increased to 20 ft 6 in.

A twin to the existing Edison Bridge across the Raritan in span lavout and type of construction, the new structure will differ from it only in roadway width and in the arrangement of the cross sections. The same fenders will be used for the channel spans of both bridges, and the remaining piers of the new bridge are offset from those of the Edison Bridge to conform to the channel location.

The piers will consist of reinforced concrete frames resting on granite-faced shafts. The river foundations will be supported on steel H-piles extending to rock, and the concrete bases are being placed under water in open cofferdams to a maximum depth of 40 ft below mean sea level. In general, the pier bases on the north shore are being constructed on cast-in-place concrete piles. The foundations on the south shore are being constructed as spread footings except for the abutment that will be supported on steel H-piles. The piers will be sufficiently wide to permit erection of an additional 30-ft roadway, if traffic requirements demand.

Members of the New Jersey Highway Authority are Ransford J. Abbott, chairman; Bayard L. England, vice-chairman-treasurer; and Orrie de Nooyer, secretary. The chief engineer of the Authority is H. W. Giffin, M. ASCE, and the consulting bridge engineer is Morris Goodkind, M. ASCE. General consultants to the Authority are Parsons, Brinckerhoff, Hall & Macdonald, Consulting Engineers. Design and supervision of construction of the Raritan River Bridge are being handled by D. B. Steinman, M. ASCE, Consulting Engineer. Contractors for the river piers are the Frederick Snare Corp., and for the land piers and abutments, the Poirier & McLane Corp. Contractor for the steel superstructure is the Bethlehem Steel Co.

Construction of the foundations was commenced early in the year and will be completed in time to permit the start of steel erection late in 1953.

Cranes work on footings for Raritan River crossing of New Garden State Parkway. Project will be twin to existing Edison Bridge, shown at left. Footings are wider than necessary to accommodate possible future roadways.

Large Derrick Speeds Canadian Refinery Project

New 150-ton erection derrick, largest of its type to be designed and built in Canada, is shown in use at Sarnia on the building of a refinery for the Sun Oil Co. Five railroad cars were needed to carry the derrick from the shops of the Dominion Bridge Company, Ltd., at Lachine, where it was designed and built. Equipped with a 160-ft boom and 180-ft mast mounted on a spherical roller thrust bearing, the derrick is designed so that the boom and mast may be used independently as poles, a frequent requirement in handling heavy vessels. An additional 20-ft section of boom is available to provide two 180-ft poles. On the Sarnia job (its first), the derrick was set on a 15-ft self-supporting steel tower, bringing the top of the mast 200 ft from ground level. Photo courtesy Dominion Bridge Co.

Cincinnati to Build New Sewage Treatment Works

Mayors of more than 350 towns and villages along the Ohio River are being invited to turn the first earth for Cincinnati's $22,000,000 Millcreek Sewage Treatment Works on October 6. Sponsored by the Clean Water Rally, the ceremonies will launch an all-day program designed to familiarize Ohio Valley residents with the construction work that is being done to make the area conform to specifications of the Ohio River Valley Water Sanitation Compact. The visiting mayors will also help dedicate the city's $6,000,000 Little Miami Sewage Works and inspect a half-completed plant at Bromley, Ky., across the river from Cincinnati, which will cost $7,600,000.

The Clean Water Rally is a civic project of the Cincinnati Chamber of Commerce and includes the participation of a number of agencies working to achieve stream sanitation in the area. Spokesmen for some of the large industries in the Cincinnati metropolitan area will be on hand, as will members of the compact commission, which is holding a quarterly meeting in Cincinnati concurrent with the rally.

Hydraulic Experts Meet at Rocky Mountain Laboratory

Both theoretical and practical aspects of hydraulic research were discussed by authorities in the field at the eighth annual meeting of the Rocky Mountain Hydraulic Laboratory at Allenspark, Colo., on August 15. Among the subjects dealt with were "Some Aspects of Roughness in Alluvial Channels," by Said M. Ali and Maurice L. Albertson, Junior Members ASCE, Colorado A. & M. College; "Cavitation Erosion of Roughened Surfaces," by Don Colgate, A.M. ASCE, U.S. Bureau of Reclamation; and "Pressure Distribution Near the End of a Pipe with Free Discharge," by Jack C. Schuster, U.S. Bureau of Reclamation.

At the trustees' meeting, the resignation of Gerard H. Matthes, Hon. M. ASCE, as president, was regretfully accepted, and Emory W. Lane elected president to replace him. A resolution was adopted thanking Mr. Matthes for his eight years of voluntary service that were instrumental in the successful establishment of the laboratory. Mr. Matthes resigned in order to have more time for his writing. Ralph W. Powell and Ralph D. Goodrich, Members ASCE, were elected trustees.

U. of Michigan Engineering College Celebrates Centennial

Completion of one hundred years of engineering instruction at the University of Michigan will be observed throughout the 1953–1954 academic year, with the official centennial program on October 23 and 24. A class in physics and civil engineering, started at the university on January 20, 1854, marked the beginning of the first technical school in the West as well as the first technical school to be supported by the public. Engineering remained a part of the original unit of the university until 1895, when the Department of Engineering was set up as a separate unit. The name was changed to the College of Engineering in 1915.

The two-day program at Ann Arbor in October will include dedication of the new Cooley Engineering Laboratory, named in honor of the late Mortimer E. Cooley, Hon. M. ASCE. As dean of engineering from 1904 until 1928, Professor Cooley molded the college into a world-famed educational unit. Another ASCE member, former Director Ivan C. Crawford, was among the six deans in the College of Engineering's hundred-year history.

Skyscraper Dedicated by Alcoa in Pittsburgh

Dedication on September 15 of the 410-ft Alcoa Building in the heart of Pittsburgh's Golden Triangle marks completion of the lightest structure for its size ever built. Begun in May 1950, the structural steel building features many innovations. The exterior walls are sheathed with 6- by 12-ft aluminum panels. The aluminum windows can be reversed for cleaning from inside the building, and an inflatable rubber tube recessed in the window frame keeps out the weather. All electrical wiring and most of the plumbing are aluminum, as are lighting fixtures, elevator cabs, partition framing, and many thousands of pounds of interior trim. The 4½-story glass and aluminum entrance—separated from the sheer 410-ft tower—is built from the top down, with the framing members suspended from two huge cantilever beams that jut out at the fifth-floor level. Twenty-five floors of the 30-story structure are occupied by the Aluminum Company of America. The Alcoa Building was designed by Harrison & Abramovitz, of New York, and constructed by the George A. Fuller Company, of New York and Pittsburgh. Edwards & Hjorth, consulting engineers of New York, were the structural engineers.

Operation of College-Owned Nuclear Reactor Planned

An agreement opening the way for operation of the first university-owned nuclear reactor in the nation has been signed by the North Carolina State College at Raleigh and the Atomic Energy Commission. Under the terms of the contract, the AEC will loan the college enough fissionable uranium 235 to fuel its recently constructed research reactor. Provision of the fissionable material, or fuel, for the unit is the culmination of a project that has been under way since 1950 when the college, under contract to the AEC, initiated design and construction of a low-powered research reactor.

One of the major objectives of the research reactor will be to supply experience to graduate and undergraduate students in nuclear engineering, a new curriculum initiated by the college in 1950. About 120 students are expected to enroll in the curriculum this year. The reactor project is under the technical direction of Dr. Clifford K. Beck, head of the college's physics department.

Guatemala Plans Port Development Program

Extensive port and harbor development of Santo Tomas, on the Gulf of Honduras in the Caribbean Sea, will get under way following award of a $4,800,000 contract of the Republic of Guatemala to the Morrison-Knudsen Company de Centro America. The contract includes dredging a 30-ft channel for large ships; construction of a 1,500-ft reinforced concrete marginal wharf, a 300-ft barge dock, and an 800- by 150-ft transit shed; and the erection of first-stage townsite buildings and utilities for the homes of government operating personnel. Completion in two years is planned.

Belgian Civil Engineer Describes Congo Development Program

The Belgian government's billion-dollar long-range program for development of the Belgian Congo was described for the benefit of United States engineers who may wish to participate in the program at a recent meeting held in the Engineering Societies Building in New York. Appearing under the auspices of the Mutual Security Agency of the Foreign Operations Administration, Gerard L. Feytmans, Royal Inspector of Colonies, Brussels, Belgium, and ministerial officer in charge of public works in the Belgian Congo, emphasized the tremendous natural resources of the area, which has iron and manganese, copper, chromium, and uranium, as well as one-fifth of the world's potential hydroelectric power.

Begun in 1949, the ten-year program includes coordination and planning of transport investment, planning and administration of the highway, waterways, and public works programs, and public administration. Mr. Feytmans said that the economic planning program is good, but that its implementation has run into difficulty primarily because of lack of adequate staff and qualified technicians in some fields. The basic objective of the present technical assistance mission is the study of theoretical and specific planning and programming techniques, methods and practices employed in the public works establishments in the United States with emphasis on general construction of highways and airports. The entire program is being financed by Belgian Congo funds.

New, fully precast, thin-shell design promises economical roof construction according to its developer, W. Sefton, A.M. ASCE, of Montreal, Canada. The roof, shown in sketches here, is cast on the ground in sections about 3 ft wide which are hoisted into position on temporary supports by mobile cranes. Holes left in the crown and eaves of each section permit the passage of prestressing wire or bars by which the shell is poststressed longitudinally. Precast ribs may also be incorporated in the design. Each shell unit contains a light mesh. Considering the elimination of falsework, the minimizing of formwork, and the reduced weight of steel per square foot, the developer figures that at current wage rates the cost in the United States would be below $2 per sq ft of floor area.

Coordinated Erection Procedures Expedite Philadelphia Viaduct Job

Two primary problems overcome in erection of Pencoyd Viaduct on Schuylkill Expressway—an important access route connecting the present eastern terminus of the Pennsylvania Turnpike with urban Philadelphia—are illustrated here. For overhead crane work the 66,000-v main power line had to be de-energized daily, while erection below was coordinated with traffic movement on the Reading Railroad tracks. In coordinating erection with railroad operations, the Bethlehem Steel Company's staff maintained continual contact with the railroad, which in turn provided flag service to warn work crews of approaching trains. The erection crew also had to arrange with the Philadelphia Electric Co. for de-energizing the power line. Erection equipment, which included a 75-ton locomotive crane and an 85-ton crawler crane, occasionally touched the de-energized wires. Under construction by the Pennsylvania Department of Highways, the 17-mile four-lane concrete expressway consists of two 28-ft roadways separated by a 4-ft center mall.

Procedure of dropping a vermiculite concrete panel in place with chain hoist, during erection of Jefferson State Office Building, Jefferson City, Mo., is shown in inset. Large view shows erection of aluminum facing, which was applied from painters' scaffolds dropped from the floor above.

Insulated Skin Wall Construction Used Again for Large Office Building

The new fourteen-story Jefferson State Office Building in Jefferson City, Mo., is an important addition to the roster of metal-faced, insulated skin-wall-enclosed buildings. Designed by the office of Marcel Boulicault, architect-engineer of St. Louis and Jefferson City, the silvery white shaft introduces a new type of lightweight exterior spandrel wall combining structural adequacy, insulation, and fire resistance in relatively small prefabricated units.

The units are precast panels of vermiculite concrete—3 in. thick, about 4 by 5 ft in size, and weighing less than 200 lb each, or about 10 psf. There are 851 panels totaling approximately 25,000 sq ft. The exposed aluminum facing consists of extruded aluminum sheets and shapes.

A tremendous dead load reduction on the structural frame was effected by this wall construction, the finished wall weighing only 14 psf compared to about 150 psf for conventional masonry. Total weight reduction effected on the building was 3,400,000 lb or 1,700 tons.

A second major advantage is the great speed of erection. Panels covering 20 sq ft in area were placed by two men in a matter of 20 min. Interior floor space was also increased. The total wall thickness is only 5 in., which added 455 sq ft of usable floor area per floor.

The panels are a 1:6 mix of vermiculite concrete (one part of Portland cement to six parts of vermiculite aggregate) which has a "K" factor of 0.76 and weighs 25 lb per cu ft. They were cast in permanent U-shaped frames of 12-gauge sheet steel and were reinforced with 6 × 6 × 10:10 wire mesh embedded in the middle of the concrete. At the top of the frame a half-inch nut was welded for ease of lifting and erection. Cast in St. Louis at the rate of 1,000 sq ft per day, the panels cured 28 days before they were trucked to the job.

All erection was done from the floor levels at which the panels occur. The aluminum facing was erected from ordinary painters' scaffolds dropped from the floor above. These factors resulted in a great saving in field labor and time, and eliminated the costly erection of full-height scaffolding. The cost of the building was $5,500,000.

Collaborating with the office of Marcel Boulicault were Ralf Toensfeldt, mechanical engineer, and W. C. E. Becker, M. ASCE, structural engineer. The general contractor was the MacDonald Construction Co. All are of St. Louis.

General Electric Will Build New Research Laboratory

Radical research in metals and related products will be hastened by a new metallurgical development laboratory to be built by the General Electric Co. The new facility, which will be a part of the company's multi-million-dollar research laboratory at the Knolls, near Schenectady, N.Y., will provide more than 70,000 sq ft of floor space, raising the gross area of the laboratory to more than 500,000 sq ft. It will be the eighth building in the research laboratory group.

Midwest to Have Large Asphalt Refining Plant

Plans for construction of a $4,000,000 asphalt refinery near Cincinnati are announced by the American Bitumuls and Asphalt Co., of San Francisco, a subsidiary of the Standard Oil Company of California. To be built on a newly acquired 100-acre tract on the Ohio River at Miami Ford, 12 miles west of Cincinnati, the plant will be especially designed for the refining of asphalt products and the manufacture of all standard grades of asphaltic products used by the paving industry. It will process a high-grade asphaltic crude brought from Venezuela to New Orleans by tanker and then shipped by barge up the Mississippi and Ohio rivers.

The plant, which will include a two-stage distillation unit, an administration building, and laboratory facilities, will be the company's fourth manufacturing facility in the Midwest area.

U. S. Steel Output Sets New Record

The steelmakinig furnaces of the United States poured over 114.6 million tons of steel in the past twelve months, an amount far above the greatest previous twelve-month output in this or any other country, according to an announcement from the American Iron and Steel Institute. This total—about 2¾ times greater than Russia's expected output for the year—includes 9,401,000 tons of ingots and steel for castings made in August 1953.

In the first eight months of the year, the steelmaking furnaces poured 76,622,609 tons, the largest amount ever made in a comparable period. The output of the first eight months last year, when production was curtailed by the steel strike, was about 55.1 million tons, and in the first eight months of 1951 it was about 69.7 million tons. August was the seventh month this year in which steel production exceeded 9,000,000 tons, and the rate of production was 94.1 percent of capacity.

Record Construction Activity in 1953 Foreseen

Expenditures for new construction this year are expected to reach $34^2/_3$ billion exceeding last year's record by 6 percent or $2 billion, according to revised outlook estimates prepared jointly by the Building Materials Division of the U.S. Department of Commerce and the U.S. Labor Departments Bureau of Labor Statistics. The dollar volume of new construction will also represent a new peak in work actually put in place, when adjustment is made for price changes. These figures are in close agreement with those of the Associated General Contractors of America released at the mid-year board meeting of the organization.

Continuation of the steady postwar climb in construction activity in 1953 is attributed, primarily, to a sharp rise in commercial building, and substantial increases in expenditures for privately owned public utility construction, private housing, and school and highway work. The only major types of construction for which expenditures are expected to decline are private industrial and farm and hospital building.

The present outlook for 1953 construction activity is based largely on relatively firm estimates of work put in place during the first seven months of the year and on documented information about work under contract, which is to continue or be completed during the remainder of the year. The former accounts for 56 percent and the latter for something over 25 percent of the expected annual total. In estimating for the balance, it was assumed that only mild readjustments in the general economy will take place this year; that close to 1,100,000 dwelling units (private and public) will be started, compared with 1,127,000 in 1952; and that the Korean truce will have no effect on construction this year, and that no other major changes in the international situation will occur to affect the construction level.

Public utility construction for the year, at $4.4 billion, is expected to be at an all-time high both in dollar volume and in physical plant installed, marking the tenth successive year of expansion. Most of the 11 percent rise in expenditures over 1952 will occur in the gas and electric light and power group, with only moderate increases in railroad and telephone and telegraph work. One-third of all new construction activity and half the outlays for private work will be for residential building ($11.7 billion).

Only about 3 out of every 10 dollars of public work will be for direct defense purposes—public industrial plant and military and naval facilities. Public industrial construction, largely work on atomic energy establishments, will advance 15 percent to a peak of nearly $1.5 billion, as construction of the Portsmouth, Ohio, facility gets into full swing. On the other hand, military and naval construction will probably be about the same as in 1952. Some projects were delayed and some may be set aside as a result of the Budget Director's instruction to review federal projects for essentiality.

NBS Dynamometers Check Huge Testing Machines

Four compression dynamometers of 3,000,000-lb capacity, which can accurately measure forces to 12,000,000 lb, have recently been completed by the National Bureau of Standards. Prior to development of these dynamometers, which make use of attached wire-resistance strain gages as part of their load-indicating systems, the highest load that could be accurately measured was approximately 2,500,000 lb.

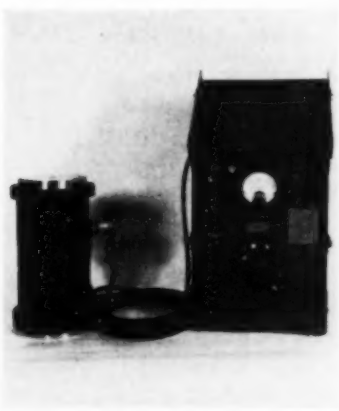
The attached-wire strain gage came into general use about 1940. The gage consists of a grid of fine wire cemented to the surface of a specimen. As the material of the specimen becomes strained under the load, the wire is likewise stretched. The change in electrical resistance of the wire mesh bears a simple relationship to the strain in the specimen and is measured by electrical instruments.

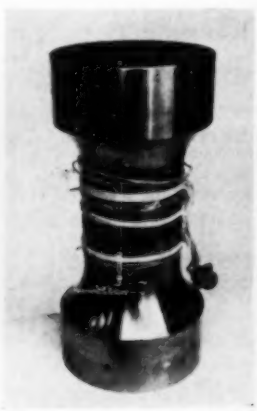
The Bureau's new type of dynamometer, illustrated here, consists of a steel cylinder with strain gages attached in such a way as to respond to the strain on the column. The feature of the design is that the cylinder is flared out at top and bottom to integral ends having much larger bearing surfaces.

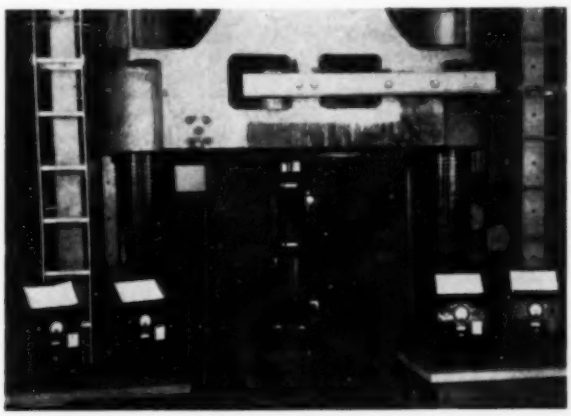
For years the Bureau has provided means of verifying the accuracy of tension and compression testing machines for industrial plants and laboratories. Typical examples of big machines are a 4,000,000-lb machine at the University of California; 5,000,000-lb machines at the Philadelphia Navy Yard and the Bureau of Reclamation in Denver; and a 10,000,000-lb machine at the Bureau of Standards in Washington. With the four 3,000,000-lb dynamometers operating in parallel, even the largest testing machine can be calibrated as accurately (within 0.1 percent) as with proving rings of 300,000-lb. capacity.

The present devices were developed under the direction of B.L. Wilson and D.R. Tate, of the Engineering Mechanics Laboratory of the Bureau of Standards.

New 1,000,000-lb dynamometer and its electrical indicating instruments (left) recently developed by Bureau of Standards consists of a turned cylinder, with its protective cover removed (center), to which are attached several resistance strain gages. At right three 1,000,000-lb dynamometers are set up in a 10,000,000-lb testing machine to calibrate one 3,000,000-lb dynamometer. With the four 3,000,000-lb dynamometers, which the Bureau has made, any existing testing machine can be calibrated up to 12,000,000 lb.







Airfield Pavements Tested with 110-Ton Load

This special pavement testing device is used by the U. S. Waterways Experiment Station at Vicksburg, Miss., to simulate, on test pavements, the traffic imposed on airfield pavements by heavy airplanes during taxiing. The load box is free to move within the yoke which serves only to keep the box balanced in an upright position. Both tractor and outrigger tires carry light loads (10,000 lb or less) and low-inflation pressure (25 psi), and consequently have no detrimental effect on pavement. The test load box, which has an empty weight of 26,000 lb can be loaded to a gross weight of 220,000 lb. Its weight is carried on various heavy plane wheel assemblies, including single-wheel, dual-wheel, and twin-tandem-wheel assemblies, which may be equipped with any of the tires in current use on heavy planes. The dual-wheel assembly, seen under the load box in this photo, is equipped with two tires spaced 37 in. center-to-center. This is the wheel assembly used on the Stratocruiser.

Water Picture for August

Runoff in August was so deficient in several areas of the United States and Canada as to cause restrictions on water use in a number of communities, according to the current *Water Resources Review*, issued jointly by the U.S. Geological Survey and the Canadian Department of Resources and Development. Notable among these areas are the Southeast, Eastern Canada, and Northern New England. Though groundwater levels for these areas were mostly normal or above normal, levels in the Southern Midcontinent region and in the Southwest were generally low. Declining groundwater levels were reported for central New England, New York, New Jersey, Pennsylvania, Ohio, Illinois, Missouri, Nebraska, Kansas, and Oklahoma. Groundwater levels in Texas rose locally as a result of heavy precipitation, but were generally lower than in July, reaching record lows in many wells. The water level in the key well near Tucson, Ariz., declined more than 3½ ft in August to the lowest level in 23 years of record.

At twelve key stations—eight in the United States and four in Canada—there were new extremes of runoff for the month. Runoff was well above normal in the Northwestern and some of the Western States, though groundwater levels were generally at low stages or about average. The high runoff in the Northwest is explained in part by delayed melting of high-altitude snow that lasted into early August.

N. G. Neare's COLUMN

R. ROBINSON ROWE, M. ASCE

"I'm mad," growled Titus Wadhouse.

"Now what?" temporized Professor Neare. "Weren't you glad to see your name in the paper?"

"Not with all your innuendos, Noah, implying inefficiency in my scheme for equalizing the spaces between tables at the Engineers' Picnic, blaming me for upsetting the lemonade, and not even asking what my system was!"

"I didn't care what your system was, Titus. I just saw a good problem and took it. A good one for Joe, here."

"Almost too easy for even me," admitted Joe Kerr. "The spaces were 10, 16, 8, 11 and 15 ft, respectively, and the total being 60, each had to become 12. At first I almost fell into your trap. You had asked what was the most any table had to be moved, and I guessed 4 ft, the difference between 12 and the second and third spaces. But I was smart enuf to notice that a space could be adjusted by moving two tables, so I compared the cumulative totals of space from one end this way:

Original	0,	10,	26,	34,	45, 60
Ultimate	0,	12,	24,	36,	48, 60
Change	0,	+2,	−2,	+2,	+3, 0

So 3 ft was the most any table had to be moved."

"I'm so glad Joe's getting smart," said Cal Klater with almost a straight face. "A few more lessons and he would be smart enuf to realize that the end tables wouldn't be frozen to the ground in August. To avoid fractions, suppose the two end tables moved inward by distances of $5x$ and $5y$ respectively so as to reduce the equalized space by $x + y$ to $12 - x - y$. Then Joe's 'change' for the 6 tables in order would become: $5x, 4x + 2 - y, 3x - 2 - 2y, 2x + 2 - 3y, x + 3 - 4y$, and $-5y$, with x and y to be found so as to minimize the largest of the absolute values of the 6 changes. The trick is to equate the right three changes so as to have two equations in two unknowns; by shrewd selection:

$$4x + 2 - y = 3x - 2 - 2y = x + 3 - 4y$$

$$x = 0.1 \text{ and } y = 7/30$$

making the 6 changes: 6, 26, −26, 18, 26 and −14 in. So 26 in. was the most that any table had to be moved."

"Nice and concise," concurred the Professor, "and let me add a nomographic solution that visualizes the selection of the 3 tables. The 6 scales in inches (Fig. 1) represent changes of the 6 tables and any isopleth intercepts changes which equalize the spaces. Line A is Joe's solution; Line B is an envelope for 30-in. changes; sliding it parallel to Line C reduces the two largest changes to meet a third at 26 in., which was Cal's answer. Now, Titus, I'm ready to ask you what your system was."

"Mine was still more efficient. It's work to shove a big picnic table in sand and I was minimizing the work. Joe moved 4 tables a total of 108 in.; Cal moved 6 tables 116 in.; I would have beat them both if I'd been let alone."

"That's a challenge," concluded the Professor. "How would you do it?"

[Cal Klaters were: Richard Jenney, Stoop (John L.) Nagle, Streamliner (Julian Hinds), Ralph W. Powell, Herman F. Finch, L. Tarango Jr., Flo Ridan (Charles G. Edson), G. Nyuss (Robert M. Dodds), and R. E. Philleo. Also acknowledged are solutions of July's Deltonian Division from Tarango and Del Awarian (George N. Hyland).]

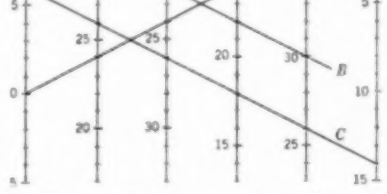


Fig. 1. The nomographic solution

The *SAFE* Pavement is *CONCRETE*

Building safe highways means giving careful attention to the design, the engineering and the pavement.

Regardless of the type of pavement selected, the fundamentals of good highway design and engineering call for adequate widths, long sight distances, low grades, broad curves, a median strip to separate lanes for opposing travel where the traffic volume is heavy and grade separations at busy intersections.

However, there is a difference in the third requisite for safe highways—the pavement. Rigid concrete can be designed accurately for any present or anticipated axle load—and it will *keep* that load-carrying capacity throughout its life. For this and other reasons described at the right concrete is the safe pavement.

For help in designing and building safe concrete highways write for a free copy of "*Concrete Pavement Design.*" It is distributed only in the U. S. and Canada.

PORTLAND CEMENT ASSOCIATION
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A national organization to improve and extend the uses of portland cement and concrete through scientific research and engineering field work

"BUILT-IN" SKID RESISTANCE

Concrete's gritty texture grips tires tightly, assuring drivers of uniformly good traction. This permits fast, safe stops without swerving or skidding, even though the pavement is wet. Concrete cooperates with tires and brakes.

BETTER NIGHTTIME VISIBILITY

Concrete's light color reflects up to four times more light than dark-colored pavements. That enables drivers to see curves, obstructions, pavement edges, animals or pedestrians sooner and more clearly and to slow down or stop safely.

EVEN SURFACE

Rigid concrete pavement retains its low crown and even surface throughout its long life. It stays free from such driving hazards as ruts and washboard wrinkles and it does not develop surface irregularities that require frequent patching.

DECEASED

John David Anderson (M. '28), age 64, for ten years engineer for the Westvaco Chemical Division, Food Machinery & Chemical Corp., New York, N.Y., died recently. A graduate of Cornell University, Mr. Anderson was employed as an industrial engineer by United Engineers & Constructors, Inc., Philadelphia, Pa., from 1929 to 1938, and the H. K. Ferguson Co., in Cleveland and New York, from 1938 to 1943.

John Henry Bateman (M. '26), age 61, since 1936 professor of civil engineering at Louisiana State University, died at his home in Baton Rouge, La., on August 23. After graduating from the University of Michigan in 1915, Professor Bateman entered the Michigan State Highway Department and served as director of its laboratories at Ann Arbor from 1919 to 1924. For four years he was also engineer-manager of the Berrien County (Michigan) Road Commission. He was the author of a standard college text, *Highway Engineering*.

Sylvanus A. Becker (M. '21), age 73, who retired in 1944 with the rank of professor emeritus after 38 years in the civil engineering department at Lehigh University, died at his home in Bethlehem, Pa., on December 27, 1952. Professor Becker served as Nazareth (Pa.) borough engineer for several years and maintained a private consulting practice during his teaching career.

Frederick Anderson Burdett (M. '03), age 80, retired consulting engineer of New York, N.Y., and Putney, Vt., died in New York City on August 12. Founder and for many years president of F. A. Burdett & Co., Mr. Burdett was instrumental in the organization of the American Institute of Consulting Engineers. He was an alumnus of the Cooper Union.

Aaron Putnam Campbell (A.M. '29), age 68, since 1933 vice-president of Gilbert Associates, Inc., Reading, Pa., died in Houston, Tex., on July 31. Connected with the Reading, Pa., firm of W. S. Barstow & Co., Inc., from 1915 to 1933, Mr. Campbell advanced from engineer to the vice-presidency. He studied at the University of Wisconsin and the University of Oregon.

James Stuart Crandall (M. '30), age 62, president of the Crandall Dry Dock Engineers, Inc., Cambridge, Mass., died at Concord, on July 20. Associated with the firm since 1915, Mr. Crandall became treasurer in 1919, vice-president in 1930, and president in 1936. From 1935 to 1941, he was visiting lecturer on harbor engineering at Harvard University. He was an alumnus of the University of Maine.

John Stanley Crandell (M. '27), age 69, professor emeritus of highway engineering at the University of Illinois, died at Boalsburg, Pa., on July 8. Professor Crandell retired in 1952 after serving in the department of civil engineering for 26 years. Prior to his association with the university he had worked for the New York Central Railroad and served on the staff of Pennsylvania State College. An authority in the highway engineering field, Professor Crandell was author of more than 600 pamphlets and technical articles. He was a graduate of City College of New York and New York University.

Bruce Lincoln Cushing (M. '25), age 69, for over 30 years a partner in the firm of Cherry, Cushing and Preble, of Buffalo and Orchard Park, N.Y., died in July 1953. Mr. Cushing had been employed by the Buffalo Forge Co., the Hooker Chemical Co., and Cundall, Powell and Mosher, which later became Cherry, Cushing and Preble.

Alexander Joseph Faulkner, Jr. (J.M. '50), age 27, since 1950 engineering trainee with the Oklahoma Natural Gas Co., Tulsa, Okla., died recently as the result of a line blast which occurred near Tulsa. Mr. Faulkner received the bachelor of science degree in civil engineering from the University of Oklahoma in 1950. He was a veteran of the Army Air Corps.

Mansfield Joseph French (M. '11), age 81, of Syracuse, N.Y., died on June 4. Following study at Syracuse University, Mr. French was engaged in railroad construction and maintenance work in upstate New York for several years. Later he was a salesman for the American Creosoting Co., the Jennison-Wright Co., and the Kreasbey & Mattison Co. Since 1935 he had been engaged in historical research.

Daniel Carter Frost (M. '49), age 47, professor of civil engineering, Valparaiso University, Valparaiso, Ind., died on May 30, 1952. Professor Frost had previously taught at Beloit College, Villanova College, the Newark College of Engineering and several technical schools. He was a graduate of Northeastern University and the Thayer School of Engineering at Dartmouth College.

William Henry Gravell (M. '13), age 70, consulting engineer of Philadelphia, Pa., and an alumnus of the University of Pennsylvania, died at his home in Philadelphia, on September 6. During a career in which he practiced both independently and in association with partners, Mr. Gravell was connected with the construction of such structures as the Pan-American and Justice Department buildings in Washington, D.C.; the Bok Tower in Florida; the Bethesda (Md.) Medical Center; and buildings for the U.S. Naval Academy, the U.S. Military Academy, and several colleges.

Louis Allen Harding (M. '38), age 76, an authority in the field of heating and ventilating, past-president of the American Society of Heating and Ventilating Engineers, and author of several books in the field, died at his home in Buffalo, N.Y., on July 8. He had taught at Pennsylvania State College, his alma mater, and other colleges. Becoming senior member of Harding & Crea in 1920, Mr. Harding later was president of the L. A. Harding Construction Corp., and at the time of his death was president of the Harding-Carlton Corp. He had also served a four-year term (1936–1940) as public works commissioner of Buffalo.

Paul Eells Jeffers (M. '30), age 64, consulting engineer of Los Angeles, Calif., and president of the California State Board of Registration for Civil and Professional Engineers since 1947, died in Los Angeles, on August 7. He was a graduate of Stanford University. In practice since 1917, Mr. Jeffers was connected with the structural design of many Southern California buildings. He was a founder of the Structural Engineers Association of Southern California and served as its first president in 1929.

Frank B. Kendall (M. '27), age 71, district engineer for Johannessen & Girand of Tucson, Ariz., died in that city on August 6. Mr. Kendall, who had maintained a general engineering practice in Tucson for several years, previously was Pima County (Arizona) Engineer and chief engineer for the Frank Meline Co., Los Angeles.

Jonathan Thomas McGrew (A.M. '27), age 58, civil engineer with the U.S. Bureau of Reclamation at Yuma, Ariz., died on April 4. Before joining the Reclamation Bureau ten years ago, Mr. McGrew was a camp superintendent for the U.S. Soil Conservation Service at Velarde, N. Mex., and assistant engineer on the Denver & Salt Lake Railway, at Denver.

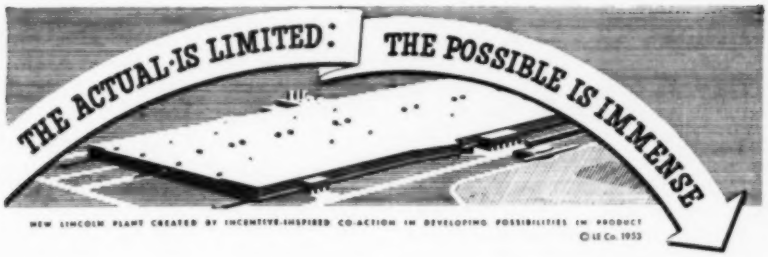
Hugh Burritt Muckleston (M. '12), age 79, consulting engineer of Vancouver, B.C., died on May 22. He had been in private practice since 1924. Earlier Mr. Muckleston was with the Canadian Pacific Railway for 17 years and the Lethbridge Northern Irrigation District for five years. He served in the Canadian Army during World War I, and had attended the Royal Military College of Canada.

George Henry Nolan (M. '14), age 77, civil engineer with the Frederick Snare Construction Co., of New York, from 1901 until his retirement in 1949, died at his home in Middleboro, Mass., on September 5. Successively, superintendent, general manager, and vice-president of the firm, Mr. Nolan for many years filled an assignment in Havana. He had also served in Turkey, Trinidad and Puerto Rico. He was a graduate of the Thayer School of Engineering at Dartmouth College.

Charles Alfred Smith (M. '21), age 78, former superintendent of roadways for the Georgia Railway and Power Co., in Atlanta, died there on August 5. Joining the power company as an engineer in the roadway department in 1906, Mr. Smith became superintendent two years later and held that position until his retirement in 1948. He graduated from the Massachusetts Institute of Technology in 1899.

Howard Macalpin Smitten (M. '30), age 75, former bridge engineer for the Western Pacific Railroad Co., at San Francisco, Calif., died on June 30 at Tucson, Ariz., where he was consulting engineer on bridge work for the Utah Construction Co. Early in his career Mr. Smitten was with the Southern Pacific Co. His connection with the Western Pacific began at the end of World War I, in which he led the 37th Army Engineers in France, and continued until his retirement in 1945. From 1946 to 1952 he was a director of the Central Contra Costa County Sanitary District.

(*Continued on page 86*)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NEW LINCOLN PLANT CREATED BY INCENTIVE-INSPIRED CO-ACTION IN DEVELOPING POSSIBILITIES IN PRODUCT
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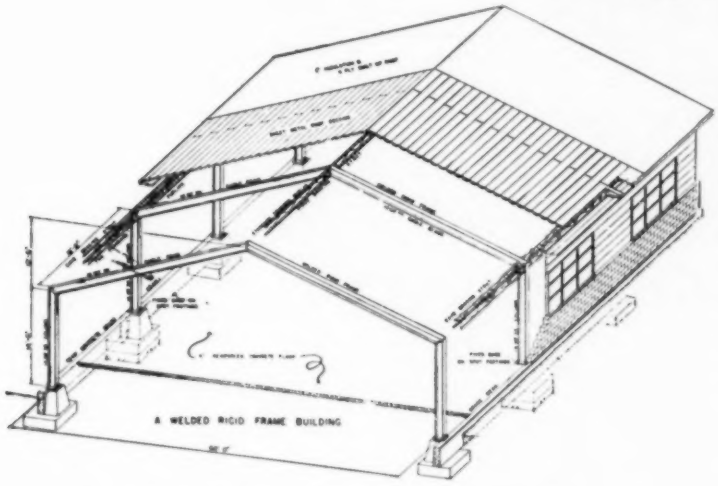

Fig. 1. Welded Frame Building *uses longitudinal rigidity of roof by running welded roof decking lengthwise.*

SIMPLE CONSTRUCTION USES PLAIN STEEL SHAPES

Eave Bracing Strut consists of two standard welded open web roof joists of the same depth as the depth of the 14" W.F. 30 lb. rigid frame beam set in positions so that one trussed purlin is normal to the roof and the other normal to the wall and with the inside edges of their bottom flanges joined together by welding to form an angle strut.

These standard purlins are butt welded to the edges of the rigid frames to constitute the main portions of the strut while the outside corner is made of another piece of bent plate.

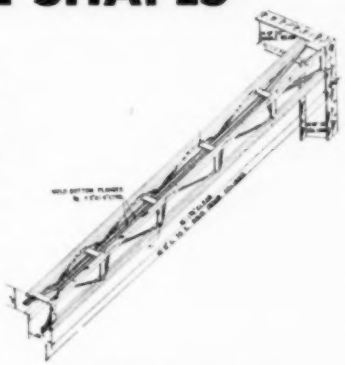

Fig. 2. *Eave bracing strut.*

This plate is bent to conform to the shape of the outside corner of the rigid frame so that it can also be butt welded in between the frames to constitute the outside corner strut.

It is then joined to the other trussed purlin sides by means of the intermediate 3" x ¼" tie plates located in the planes of the roof and wall surfaces. Thus a strong and sturdy box strut is made of standard and easily obtainable elements so that it will brace the knee against all of the various and sundry forces that can combine to cause buckling.

Studies in Structural Arc Welding free on request.
Designers and engineers write on your letterhead to Dept. 2403.

THE LINCOLN ELECTRIC COMPANY
CLEVELAND 17, OHIO

THE WORLD'S LARGEST MANUFACTURER OF ARC WELDING EQUIPMENT

DESIGN IDEA CUTS COST 20% SAVES STEEL

By **Ned L. Ashton**
Consulting Engineer
Iowa City, Iowa

THE popularity of the rigid frame type of building for such structures as warehouses, industrial plants, churches, bowling alleys, swimming pools, gymnasiums, auditoriums, garages, super-markets, etc., demonstrates its attractiveness and efficiency.

By eliminating splice plates and rivets, and utilizing the benefits of rigid framing, cost savings averaging 20% are realized on many types of building construction. Fewer man-hours and simpler equipment are required for erection.

At the present time most rigid frame buildings, made possible by arc welding, are built as two hinged frames with auxiliary purlins and girts running lengthwise of the building to support roof decking and sidewall material running crosswise. The purlins, usually consisting of small channels or angle and zee bar sections or light open web welded joint sections, are placed on top of the frames and the strength of the decking is not utilized for any other purpose.

The building frame in Fig. 1 is made differently. It consists of a typical 60′ x 150′ building 14 feet high at the eaves and 24′ at the center. The metal decking rests directly on top of the rigid frames and spans lengthwise of the building without the aid of any other auxiliary purlins.

When the roof decking is combined with the bracing purlins at the eaves and with the ridge strut it constitutes a strong lateral girder which prevents the intermediate rigid frames from moving sideways at the eaves.

Longitudinal rigidity of the roof, which is accomplished by running the decking lengthwise, constitutes an improvement compared to the conventional type of two hinged frame buildings with auxiliary purlins.

The bracing action of the roof is so helpful that the rigid frames can all be fixed at the bases with ordinary sized footings and the frames can be made of ordinary smaller sized wide flanged "I" beams throughout the full length of the frame without any special haunched or tapered sections at the knee.

(*Continued from page 84*)

Thomas Edward Snook (M. '97), age 89, former senior partner in the New York architectural firm, John B. Snook's Sons (now John B. Snook's Sons–Victor C. Farrar), died at his home in New Windsor, N.Y., on August 13. After graduating from the Columbia University School of Mines in 1884, Mr. Snook entered the office of his father as an engineer, succeeding him as head of the firm in 1901. He had been in retirement for the past twenty years.

Frank Alger Spaulding (A.M. '11), age 78, retired architect and civil engineer of Pittsfield, Mass., died suddenly at his home there on June 17. An alumnus of the Massachusetts Institute of Technology, Mr. Spaulding was associated with Jay P. Barnes in the Pittsfield firm of Spaulding & Barnes for many years.

Harry Herman Steinhauser (M. '28), age 66, civil engineer with Ebasco Services Inc., New York, N.Y., died on June 19. Employed on many international hydroelectric projects, Mr. Steinhauser worked for the Electric Bond and Share Co., in the United States, Mexico and Brazil; for the Puerto Rico Reconstruction Administration on the Dos Bocas Dam; and for Morrison-Knudsen Afghanistan, Inc., in Afghanistan.

Nimmagadda Kutumba Venkata Subba Rao (J.M. '49), age 30, assistant engineer for the Public Works Department of the Government of Madras, India, died recently. After graduating from the College of Engineering at Guindy, Madras, in 1944, he entered the Public Works Department as engineer supervisor. At the time of his death he was serving on the Pennor Dam Subdivision of the Kistno Pennor Project.

William Wadsworth Wilkerson (A.M. '29), age 51, consulting engineer of Fort Worth, Tex., died on July 1. Before entering private practice, Mr. Wilkerson served as resident engineer for the Texas State Highway Department for more than ten years. He was an alumnus of Texas A. & M. College, class of 1924.

NEWS OF ENGINEERS

John W. Bell, project engineer for the Aramco Overseas Co., is being transferred from Rome to the company's new offices in The Hague, Netherlands. Mr. Bell has been handling sanitary and waste problems for his company's oil drilling support and refinery operations in Saudi Arabia.

John M. Bird, for the past seven years chief of the design section, Foundation and Materials Branch of the Los Angeles District of the Corps of Engineers, has been assigned to the post of assistant chief, Frozen Ground Applied Research Branch at the Snow, Ice and Permafrost Research Establishment at Wilmette, Ill.

James R. Bissett succeeds **Dr. W. B. Stiles** as associate director of the Engineering Experiment Station at the University of Arkansas. In addition to his new duties, he will continue as professor of civil engineering at the university.

Raymond L. Brandes has rejoined the Nicholson Co., New York City, as vice-president and chief engineer, and its parent company, the Wininger Construction Corp., as chief engineer. His experience has been chiefly in the bulk storage and industrial building fields. Mr. Brandes is chairman of the ASCE 1953 Annual Convention Committee.

George A. Burpee has been transferred from San Antonio, Tex., to El Centro, Calif., where he is serving as resident engineer for Gibbs and Hill on construction of a hydroelectric plant on the All-American Canal for the Imperial Irrigation District.

Joseph C. Patrick, a June graduate of Purdue University, is now on the personal staff of Borough Engineer Michael S. Kachorsky of Manville, N.J.

Louis H. Herschler, engineer in charge of distribution for the Honolulu Board of Water Supply, has been appointed planning engineer by the newly created Hawaii Irrigation Authority.

Herbert D. Vogel, Southwest Division Engineer, Corps of Engineers, Dallas, Tex., recently received the Award of Merit for safety from the Department of the Army. The accident and fatality rate of the Division under Colonel Vogel's command decreased 28 percent last year.

Dewey S. Wright, deputy city engineer of Denver, Colo., has been appointed city engineer. In his new capacity he replaces **Terry J. Owens** who has joined the Automotive Safety Foundation in Washington, D.C.

Richard S. Holmgren, who recently succeeded the late **Joseph L. Burkholder** as general manager and chief engineer of the San Diego County Water Authority, took the oath of office in August as a member of the Board of Directors of the Metropolitan Water District of Southern California. On the Board he is filling another vacancy caused by Mr. Burkholder's death.

Frederic L. Copeland retired on July 15 as vice-president and director of the Bates & Rogers Construction Corp., San Francisco, Calif., after 48 years of service.

C. George Dandrow, vice-president of the Johns-Manville Sales Corp., and general sales manager of the company's Industrial Products Division, has been designated a member of the advisory board of the 57th Street office of the Manufacturers Trust Company in New York City.

Herman Danforth, until recently with Harland Bartholomew and Associates, St. Louis engineering and planning firm, as chief engineer of their Honolulu office, has accepted an appointment as city engineer of Rockford, Ill.

Robert DeMoyer, associate professor of mechanics at Lafayette College, has succeeded **Prof. William S. Lohr** as head of the civil engineering department, and has been advanced to the rank of full professor. A member of the faculty since 1942, Professor DeMoyer taught at the Pennsylvania Military College from 1935 to 1942.

David E. Donley, who has been serving as chief of the Hydrologic Studies Office of Region 1, U.S. Bureau of Reclamation, Boise, Idaho, has left for Lebanon to join the technical cooperation mission of the Foreign Operations Administration as hydrologist on plans for developing the Litani River.

John G. Duba, formerly assistant professor of civil engineering at the Illinois Institute of Technology, has resigned to accept a position as engineer in the Commissioner's Office, Department of Public Works, City of Chicago.

Elmer I. Fiesenheiser succeeded **Frank W. Edwards** as director of the civil engineering department at the Illinois Institute of Technology on September 1. Professor Fiesenheiser went to the school in 1943 as

Executive Secretary
American Society of Civil Engineers
33 West 39th Street
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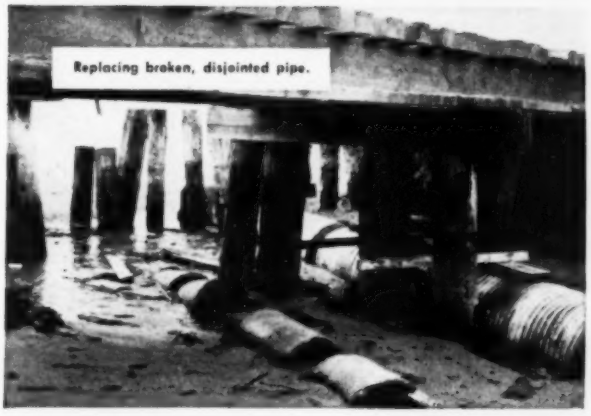

Replacing broken, disjointed pipe.

Aerial sewer over swampy land.

Storm drain outfall into ocean.

Why do contractors like Armco Sewers? Because they are integral conduits? Because they combine strength with light weight and flexibility? Yes, all these reasons help—but the *low installed cost* of Armco Corrugated Metal Pipe is the convincing factor for difficult sewer applications.

Whether conditions are normal or hazardous, you'll find sewer installations more profitable with Armco Pipe. Long, 20-foot lengths speed the work. Light weight simplifies handling and hauling. And simple bolted coupling bands join sections together tightly, permanently. A small crew handles the whole job. With these labor-saving advantages it's easier to submit lower bids without sacrificing profit.

In most normal sewer installations the heavy galvanized coating on Armco Corrugated Metal Pipe provides ample protection. For severe corrosion there is Armco ASBESTOS-BONDED Pipe. Armco PAVED-INVERT Pipe will solve erosion hazards. All are available in diameters from 8 to 96 inches.

No matter what service conditions are encountered, there is a type of Armco Drainage Structure to meet exact requirements—economically. Write for details. Armco Drainage & Metal Products, Inc., 3413 Curtis St., Middletown, Ohio. Subsidiary of Armco Steel Corporation. In Canada: write Guelph, Ont. Export: The Armco International Corporation.

Armco Sewer Structures

ARMCO

an instructor and became a full professor in 1951. He has also served as structural engineer for private companies and the government, and has done consulting work.

William H. Claire was recently promoted from the position of redevelopment planning architect to assistant executive director for the Community Redevelopment Agency of Los Angeles. During the past two years, he has been engaged on the planning of eight redevelopment projects. Before his connection with the Community Redevelopment Agency of Los Angeles, Mr. Claire was a staff member for several consulting firms in various parts of the country.

William H. Claire

D. A. Firmage recently resigned as associate professor of civil engineering at the University of Florida to accept a position with the firm of Patchen and Zimmerman, consulting engineers of Augusta, Ga. His present assignment is on the rehabilitation of the Holston Ordnance Works at Kingsport, Tenn.

Albert C. Giesecke, who recently retired as hydraulics engineer with the Minnesota Power and Light Co., at Duluth, Minn., is planning to engage in consulting practice, specializing in water resources and water utilization problems.

John F. Hall, previously district engineer for the Portland Cement Association in New York City, is now assistant to the vice-president of the North American Cement Co., New York.

William G. Hamlin, a sanitary engineer and specialist in industrial waste-control engineering, has joined the staff of the Ohio River Valley Water Sanitation Commission. During the past seven years he has been engaged in the development of waste disposal measures for the Proctor and Gamble Co., in Ohio, Florida and California.

Henry G. Harlow, professor of civil engineering and chairman of the civil engineering department at Union College, has been named chairman of the college's engineering division. He was acting chairman of the engineering division in 1950 and 1951.

E. S. Harrison has been promoted from hydraulic engineer to assistant chief engineer in the mechanical division of the Georgia Power Co., Atlanta, Ga. He has been with the company since 1939, and previously was with the Tennessee Electric Power Co.

George E. Large, since 1947 chairman of the department of civil engineering at Ohio State University, has resigned the chairmanship to devote his full time to teaching and research in the field of reinforced concrete design. He will be succeeded for the academic year 1953–1954 by **Prof. Kenneth W. Cosens** of the civil engineering faculty, as acting chairman of the department. Professor Cosens has been a member of the staff since 1949.

James H. Le Van, senior sanitary engineer with the U. S. Public Health Service, has been assigned to the Federal Housing Administration to review plans for and supervise construction of the water supply and sewerage systems for the new municipality of Levittown, Pa.

Joseph Marin, professor of engineering mechanics and research professor of engineering materials at Pennsylvania State College, has been made head of the college's department of engineering mechanics.

Theodore T. McCrosky, formerly a member of the firm, McHugh and McCrosky, is opening his own office at the same street address, 23 East 26th Street, New York City. Mr. McCrosky will specialize in surveys, reports and analyses of community, municipal and industrial problems, and allied fields.

Samuel B. Morris, general manager and chief engineer for the Department of Water and Power, City of Los Angeles, was awarded the honorary degree of doctor of laws from the University of California during the past commencement season. Mr. Morris is new ASCE Director-elect for District 11.

Melvin J. Noth has been selected to fill the unexpired term of city engineer for the city of Menasha, Wis. Since 1946, Mr. Noth has been principal engineer for the Davy Engineering Co., at LaCrosse, Wis.

F. Robert Preece, for the past six years, an engineer for the Bethlehem Pacific Coast Steel Corp., in the Los Angeles area, has just been appointed district engineer, Fabricated Steel Construction, in the San Francisco area. He will maintain offices at the company's Alameda Fabricating Works.

George J. Rettig is one of six long-time associates in the Chicago firm of Alvord, Burdick & Howson recently admitted to partnership in the firm.

John Sardis is a partner in the recently organized firm, Mission Engineers, located at 1555 Lafayette Street, Santa Clara, Calif. A specialist in structural design, Mr. Sardis has been in private practice since February 1952.

Ivan Sattem, special assistant to the vice-president, Laboratory of Advanced Research, Remington Rand, Inc., South Norwalk, Conn., was recently elected a member of the Board of Trustees of the Association of Graduates of the U.S. Military Academy. Colonel Sattem, a 1940 West Point graduate, was chief engineer of the New York State Power Authority before joining Remington Rand in February 1952.

Harland Bartholomew and Associates announce the affiliation of **William M. Wachter** as consulting engineer at Honolulu. Chairman of the University of Hawaii engineering department, Professor Wachter will continue his teaching at the university.

Charles T. West has been appointed acting chairman of the department of mechanics in the college of engineering at Ohio State University, effective October 1. Dr. West has been on the faculty there since 1946.

Warren E. Wilson, former president of the South Dakota School of Mines and Technology, is now associated with the Office of Ordnance Research, Duke University, Durham, N.C.

Roy L. Wooldridge, assistant professor of coordination at Northeastern University, was recently named director of the Cooperative Work Department at the University. A member of the faculty since 1949, he is assuming charge of the department that places students in cooperative jobs throughout New England.

Activities of the civil engineering division of the American Society for Engineering Education will be directed by the following officers during the coming academic year: **A. J. McNair,** chairman; **W. J. Eney,** vice-chairman; **R. L. Peurifoy,** secretary; **G. B. Lyon,** editor, "Civil Engineering Bulletin"; **E. H. Gaylord,** member of the council for 1954; **J. W. Hubler,** director; **C. E. Kindsvater,** director; and **D. F. Peterson,** director. All are members of ASCE.

Joseph Meltzer, president of National Structures Corp., announces the removal of the firm's executive offices from 10 East 40th Street, New York City, to 4-34 26th Avenue, Long Island City 2, N.Y.

W. H. Bradford, right-of-way engineer with the Maine State Highway Department at Augusta, has been advanced to administrative head of the Right-of-Way Division.

Percy L. Coleman resigned as senior structural engineer with Sverdrup and Parcel, Inc., consulting engineers, St. Louis, Mo., August 1, to enter private consulting practice at 1376 Kingsland, St. Louis. Prior to his association with Sverdrup and Parcel, Mr. Coleman was chief structural engineer in the General Engineering Department of the Monsanto Chemical Co.

Percy L. Coleman

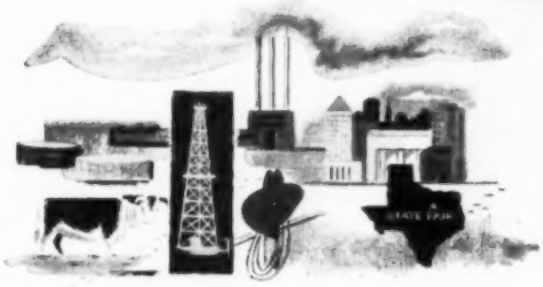
Paul J. Brennan, former member of the civil engineering faculty at Yale University, has been appointed chairman of the department of civil engineering at the University of Delaware.

W. T. Cox, who has been serving in the engineering department of the office of the City Engineer of Charlotte, N.C., is now director of public works and city engineer of Gastonia, N.C.

Emerson C. Itschner, North Pacific Army Corps division engineer at Portland, Oreg., has been promoted from the rank of colonel to brigadier general.

Lloyd W. Weed, New York consulting engineer, announces that his office is now located at 51 East 42nd Street.

Dallas Prefers Concrete Pressure Pipe



In 1915 Dallas installed the first concrete pressure pipe in its water supply system. Since 1945 several additional miles have been built, and at present a new 23,300 ft. line is under construction.

Dallas engineers prefer concrete pressure pipe because it is easy and economical to install—it requires little or no maintenance—and it has a permanent high carrying capacity. Another important reason for its selection is that water pumped through concrete pressure pipe stays clean—thereby minimizing any odor, taste, and color difficulties.

Like Dallas, many other cities, large and small, are specifying concrete pressure pipe for their water systems. If your city is planning additional water lines, or replacements for old lines, be sure to investigate the advantages of concrete pressure pipe.

Water for Generations to come

Concrete PRESSURE Pipe

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RECENT BOOKS

Advances in Applied Mechanics, Volume III

Eight papers by specialists are presented in this volume, edited by Richard von Mises and Theodore von Kármán, and dealing with important subjects of present-day research: Boundary layer problems in applied mechanics; aerodynamics of blasts; shocks in mixed subsonic-supersonic flow patterns; vortex systems in wakes; theory of the ideal plastic body; methods of analysis of non-autonomous systems; and two papers on fluid flow. (Academic Press Inc., 125 East 23rd St., New York 10, N.Y., 1953. 324 pp., $9.)

Aluminum in Iron and Steel

The first of a new series of Alloys of Iron Research monographs, this book, *Aluminum in Iron and Steel* by Samuel L. Case and Kent R. Van Horn, gives an exhaustive critical review of research on aluminum in modern ferrous metallurgy. It summarizes for the practical metallurgist, engineer, and foundryman essential information scattered through hundreds of journals and books in many languages. The first part provides data on the effect of small additions of aluminum to molten steel as a deoxidizer; the second part correlates research on the effect of aluminum as an alloying element in steel. (John Wiley & Sons, Inc., New York 16, N.Y., 1953. 478 pp., $8.50.)

Anniversary Volume on Applied Mechanics

The 19 papers contributed to this volume cover a wide range of topics from pure mathematics to structural design, including stress analysis, combustion theory, vibration, pressure-measuring devices, and a variety of problems in the field of applied mechanics. The book, dedicated to C. B. Biezeno, also contains a brief biography and a bibliography of the writings of this Dutch mechanical engineer who organized the first International Congress for Applied Mechanics. (De Technische Uitgeverij H. Stam, Haarlem, Netherlands, 1953. 328 pp., 20 Fl.)

Engineering Drawing

A text and reference book for the student or practicing engineer, arranged by the author, Frank Zozzora, for easy progress in study, which begins with the basic elements and leads through geometrical constructions to sectioning, auxiliary views, intersections and developments, and various specialized depictions. Carefully chosen illustrations and selected problems amplify and demonstrate the text content. (McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N.Y., 1953. 369 pp., $5.)

Introduction to Engineering Economy

A textbook for engineering students, in which the relation of such subjects as accounting, valuation, investment theory, statistical methods, and general economics to the management of engineering enterprises is explained. The subject matter remains substantially the same as in the previous edition but the material has been revised to conform with recent developments. The authors are Baldwin M. Woods and E. Paul De Garmo. (Macmillan Company, 60 Fifth Ave., New York 11, N.Y., second edition, 1953. 519 pp., $6.)

Public Health Engineering

The aspects of public health engineering discussed by Peter C. G. Isaac in this book are the provision of an adequate water supply, the treatment and disposal of solid and liquid wastes, and the causes and prevention of the harmful effects of air pollution. A chapter on district heating is also included because of its bearing on air pollution and problems of the water engineer. The emphasis is on general principles and their applications. (E. & F. Spon Ltd., London, 1953. 277 pp., 30s.)

Railroad Engineering, Volume I

Part One of this book—devoted to principles of operation and location of modern railroads—considers such problems as distances, curvature, locomotive operating characteristics, and gradients, in relation to location of routes and choice among alternate routes and operating procedures. Part Two discusses principles of maintenance and construction, with extended treatment of roadbed stabilization. Throughout, costs are stressed, as are recommendations of the A.R.E.A. The author is William W. Hay. (John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1953. 483 pp., $7.50.)

Symposium on Direct Shear Testing of Soils

An evaluation of the direct shear test including samples from highway and earth work practice, tests under varying conditions, and determinations of the characteristics of different soil materials. Six papers are given with the panel discussion in this Special Technical Publication No. 131. (American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., 1953. 87 pp., $2.)

Textbook of the Materials of Engineering

Elementary in character, this book by Herbert F. Moore and Mark B. Moore, is devoted to the common materials—metals, wood, concrete, building stone, ceramics, etc.—used in structures and machines, including brief descriptions of their manufacture and fabrication. Primary emphasis is placed on the strength, toughness, and stiffness of stress-carrying materials. Information on recently developed materials has been added in this new edition. (McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N.Y., eighth edition, 1953. 372 pp., $6.)

1952 Book of ASTM Standards, Including Tentatives

Part 1: Ferrous Metals. 1,602 pp., $12
Part 2: Non-Ferrous Metals. 1,359 pp., $10
Part 3: Cement, Concrete, Ceramics, Thermal Insulation, Road Materials, Waterproofing, and Soils. 1,656 pp., $12
Part 4: Paint, Naval Stores, Wood, Fire Tests, Sandwich Constructions, Building Constructions. 1,182 pp., $10
Part 5: Fuels, Petroleum, Aromatic Hydrocarbons, and Engine Antifreezes. 1,282 pp., $10
Part 6: Rubber, Plastics, and Electrical Insulation. 1,520 pp., $12
Part 7: Textiles, Soap, Water, Paper, Adhesives, and Shipping Containers. 1,364 pp., $10

Now covering more than 2,000 specifications, tests, etc., this new combined edition contains all of the standards, adopted and tentative, as of the present date. In order to accommodate the increased number of items the present edition is in seven volumes instead of six. Each volume is complete with detailed subject index, both classified and numerical lists of standards, and arranged to provide technologists and others with as usable a book as possible. (American Society for Testing Materials, 1916 Race St., Philadelphia 3, 1953. $76 per set of seven parts.)

Library Services

Engineering Societies Library books may be borrowed by mail by ASCE members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 33 West 39th Street, New York 18, N.Y.

New Publications

Public Grounds Maintenance. Out of years of study and experience in the maintenance of public grounds surrounding its dams and powerhouses, the Tennessee Valley Authority has made available an authoritative 500-page compilation in the field called *Public Grounds Maintenance Handbook*. The handbook assembles technical information on such subjects as lawn and grass culture and maintenance, weed control, insect and disease control, erosion control, road and parking area maintenance, and materials and building specifications. Copies, priced at $5 each, may be obtained from the Tennessee Valley Authority, Old Post Office Bldg., Knoxville, Tenn. Checks should be made payable to the Tennessee Valley Authority.

Snow Surveys. Hydrometeorological data, obtained by the Corps of Engineers at its Central Sierra Snow Laboratory during the water year, October 1951–September 1952, are reported in a recently issued 214-page Hydrometeorological Log of the Central Sierra Snow Laboratory. Inquiries should be addressed to the South Pacific Division of the Corps of Engineers, San Francisco, Calif.

Construction in the Tropics. Issuance of the proceedings of the two-day Conference on Housing and Building in Hot-Humid and Hot-Dry Climates, sponsored last November by the Building Research Advisory Board, is announced by the Board. Copies of the 177-page report, containing 17 papers by leading technologists and identified as BRAB Conference Report No. 5, may be obtained from the Building Research Advisory Board, 2101 Constitution Avenue, Washington, D.C. The price is $6 apiece. Available from the same organization without charge is a preliminary bibliography in the field, which is organized into seven major categories.

Water Measurement. Bureau of Reclamation engineers have prepared the first edition of a new handbook, *Water Measurement Manual*, which supersedes *Measurement of Irrigation Water*, a booklet that appeared in five editions, and the tentative *Manual for Measurement of Irrigation Water*, published in 1947. In pocket size, flexible binding, and completely indexed, the 271-page publication sells for $1.50. Requests should be sent to 841 Denver Federal Center, Denver, Colo., or to the Superintendent of Documents, Washington 25, D.C., with remittances payable to the Treasurer of the United States.

Refuse Disposal. *How to Construct a Sanitary Fill* is the title of a new twelve-page booklet made available by the Drott Manufacturing Corp. for the convenience of city officials, contractors, and engineers interested in a simple and economical method of refuse disposal. The bulletin covers initial planning, compacting, loading, spreading and finishing. Free copies are available from the Drott Manufacturing Corp., Milwaukee 8, Wis.

Highway Directory. Availability of its current annual directory of highway officials and engineers is announced by the American Road Builders Association. The pocket-sized volume contains approximately 1,600 names, titles, and addresses of administrative engineers and officials in the 48 state highway departments, the District of Columbia, and the Bureau of Public Roads. An added feature of the 1953 edition is a listing of the administrative personnel of all toll road authorities functioning in the various states. Copies, priced at $1 each, may be obtained from the ARBA, World Center Building, Washington 6, D.C.

Engineering Research. Current research in the major engineering schools of the country is summarized by the Engineering College Research Council of the American Society for Engineering Education in a new edition of its biennial *Review of Current Research and Directory of Member Institutions*. Data given for the 103 member institutions of the Council indicate that more than 13,000 faculty, graduate students, and research engineers are currently engaged in such research at an approximate annual expenditure of $65,000,000. Copies of the volume, at $2.50 each, may be obtained from V. E. Neilly, Secretary, ECRC, 103 Mechanical Engineering, Pennsylvania State College, State College, Pa.

Non-ASCE Meetings

American Concrete Institute. Emphasis will be placed on concrete construction practices and techniques at the Southwest Regional Meeting of the American Concrete Institute, to be held at the Rice Hotel, Houston, Tex., October 29–30.

American Public Health Association. The American Public Health Association holds its 81st annual meeting in New York City, November 9–13, with sessions at the Hotels Statler and New Yorker.

American Public Works Association. Headquarters for the 59th annual Public Works Congress and Equipment Show will be the Municipal Auditorium in New Orleans, La., October 26–29.

Chi Epsilon. Henry T. Heald will address the annual dinner meeting of the New York Alumni Chapter at the Governor Clinton Hotel, New York, N.Y., on October 23, at 6:30 p.m. (Dinner—$6.50 per person.) The regular meeting will be held at 33 West 39th Street, on November 4, at 7:30 p.m., preceded by an informal dinner in the New York Times Dining Room at 6 p.m.

Conference on Porcelain Enamel. Joint sponsors of the Conference on Porcelain Enamel—meeting at the National Academy of Sciences in Washington, D.C., November 12–13—are the Porcelain Enamel Institute and the Building Research Advisory Board.

Fourth Conference on Coastal Engineering. The Council on Wave Research of the Engineering Foundation at the University of California is sponsoring the Fourth Conference on Coastal Engineering, at the Del Prado Hotel, 5307 South Hyde Park Boulevard, Chicago, Ill., October 29–31. Inquiries should be directed to the Secretary of the Council on Wave Research, Engineering Foundation, 245 Hesse Hall, University of California, Berkeley, Calif.

Joint ASEE-ECPD Meeting. A joint meeting of the American Society for Engineering Education and the Engineers Council for Professional Development will be held at the Hotel Statler, New York, N.Y., October 14–17.

Mid-Century Conference on Resources for the Future. Resources for the Future, Inc., a non-profit corporation for research and education in the field of natural resources, will conduct the Mid-Century Conference on Resources for the Future, in Washington, D.C., December 2–4, with the aid of a grant from the Ford Foundation.

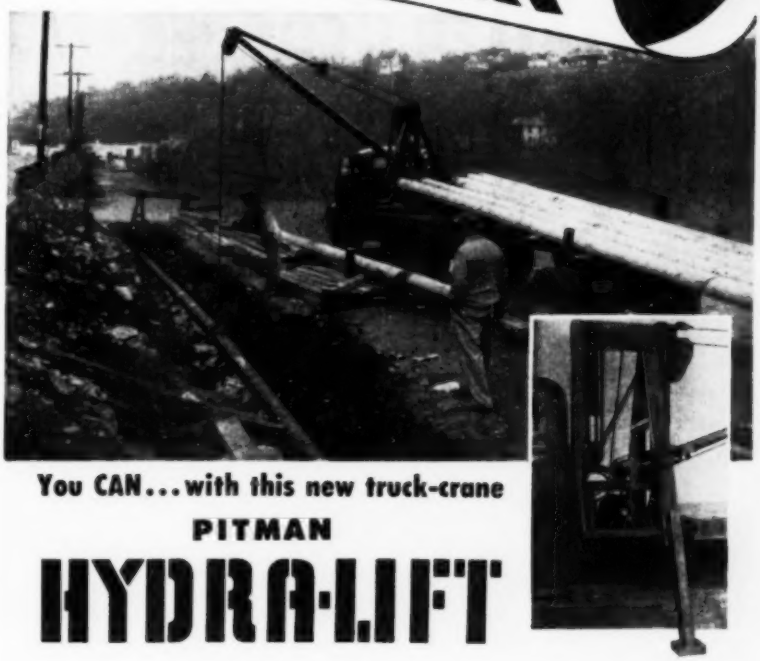
National Council of State Boards of Engineering Examiners. Headquarters for the 32nd annual meeting of the National Council of State Boards of Engineering Examiners will be the Plaza Hotel, San Antonio, Tex., October 29–31.

National Metal Congress and Exposition. The Society for Non-destructive Testing will hold its 35th National Metal Congress and Exposition at the Hollenden Hotel, Cleveland, Ohio, October 17–23.

National Safety Congress and Exposition. The 41st annual convention of the National Safety Council—the National Safety Congress and Exposition—will hold meetings at the Conrad Hilton, Congress, Morrison,

(*Continued on page 92*)

Want to handle pipe CHEAPER?



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Mount a Pitman Hydra-Lift on one of your trucks and with this single piece of equipment, you can handle pipe faster and cheaper than you can with the *two or more* pieces of equipment you are now using!

How? With its swinging boom, Hydra-Lift loads pipe directly onto a trailer pulled by the same truck on which Hydra-Lift is mounted. The truck and trailer then move to the job site at normal truck speeds. At the job, Hydra-Lift is right there, ready to swing the pipe off the trailer, then lay it in the ditch. How many pieces of equipment are you tying up to do this work now?

Hydra-Lift mounts on almost any truck; two tons or larger recommended. Hydraulic power swings the boom 180°, lifts it through an arc of 100°. Boom telescopes from 12 to 17 to 22 feet. Loadline capacity up to 6400 pounds. Yet Hydra-Lift requires but 40 inches behind your truck cab. *Hundreds* of Hydra-Lifts are being used by contractors and utility companies all over the country to cut pipe handling costs!

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Please send me more information about the low-cost Hydra-Lift.

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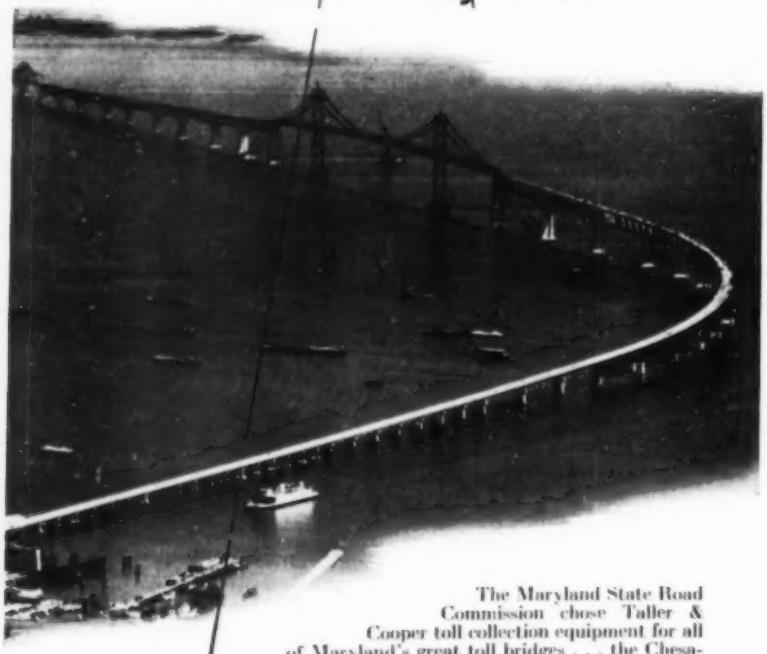

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TALLER & COOPER TOLL COLLECTION EQUIPMENT IS USED ON EVERY MAJOR TOLL FACILITY IN THE U. S.

(Continued from page 91)

La Salle, Palmer House, and Hamilton hotels in Chicago, Ill., October 19–23.

Second Annual Conference on Atomic Energy. British, Canadian and American leaders in the field of atomic energy will present addresses before the National Second Industrial Annual Conference on Atomic Energy—sponsored by the National Industrial Conference Board—at the Waldorf-Astoria Hotel, New York, N.Y., October 29–30. There will be six sessions, a dinner, luncheon, and a field trip to the Brookhaven Atomic Installation (Oct. 28).

Sixth Annual Illinois Traffic Engineering Conference. Joint sponsors of the Sixth Annual Illinois Traffic Engineering Conference at the University of Illinois, Urbana, November 3–4, are the department of civil engineering at the university, the Illinois Division of Highways, the Illinois Municipal League and the Midwest section of the Institute of Traffic Engineers.

Society of Automotive Engineers. The International Production Meeting and Forum of the Society of Automotive Engineers are scheduled for the Royal York Hotel, Toronto, Canada, October 29–30. The Conrad Hilton in Chicago, Ill., will be headquarters for the Transportation Meeting, November 2–4; the Diesel Engine Meeting, November 3–4; and the Fuels and Lubricants Meeting, November 4–6.

Steel Joist Institute. The semiannual meeting will be held at the Greenbrier, White Sulphur Springs, W. Va., October 13. The Institute address is Dupont Circle Building, Washington 6, D.C.

Solution to problem on page 60

The original plans for removal of the bents involved cutting the piles free from the caps, pulling and redriving them in the new location, and resetting the caps. The contractor, however, obtained permission from the Park Department to move the 4-pile bents as units, since it was found that the bents could be jetted free at the old site and moved by a crane to the new location, where they could be jetted in place, thus avoiding the considerable work of dismantling and reassembling.

A steel truss was built to distribute the lifting force of the crane evenly to the four piles, thus permitting lifting and transfer of the bents as units. The truss assembly was hung from the 60-ft boom of a tractor crane which traveled on the sand beach on heavy timber mats. The truss was clamped to the four piles by metal clips. Eight jet pipes, two per pile, hung from a steel rectangular harness and raised and lowered by means of hand winches, were sunk along the sides of the piles. The boom was then raised and the freed assembly was carried bodily inshore, where it was jetted into place.

In all, 200 double bents—400 individual units of 4 piles and cap assemblies each—were thus moved.

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EXPERIENCED FABRICATORS AND ERECTORS OF
STRUCTURAL STEEL
FOR
INDUSTRIAL PLANTS . COMMERCIAL BUILDINGS . HOSPITALS
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Why not take advantage of this broad experience and specialization on your next structural steel project?
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YUBA PLACER DREDGE DIGS, TREATS, STACKS 18,000 TONS GRAVEL DAILY...

This placer dredge with 18 cu. ft. buckets digs to 125' below water, averages better than 22 hours running time daily. Intricate treatment equipment on board limits digging to only 18,000 tons of gravel per day. For sand and gravel digging only, an 18 cu. ft. YUBA dredge can produce as much as 40,000 tons daily.

5¢ Per Ton

YUBA gold dredges of this type can be converted readily to produce and size gravel at total operating costs substantially under 5¢ a ton. One big advantage—they float in their own ponds and excavate gravel without lowering surrounding water levels.

Long Operating Life

With YUBA dredges you get both low production costs and long operating life—many YUBA dredges are operating efficiently after 25 years or more of rough service.

Consult YUBA NOW. We will design and build a new dredge to fit your ground; or help you find a used dredge, and move, redesign and rebuild it. Wire, write or call us—no obligation, of course.

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Applications for Admission to ASCE August 8–September 5

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(*Continued on page 99*)

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WASHO road test . . .

(This article begins on page 45)

(Continued from page 47)

the pavement structure and at the surface of the pavement. Differences between surface and structure deflections are deflections of the subgrade itself.

The basic element or transducer used to convert deflection into changes in electrical potential for recording, is the LVDT, as used in the profilometer. The greatest problem here was to find a satisfactory means of anchoring the transformer body to one element in the pavement, and the core to another. Perforated plates on the subgrade were placed during construction, long steel reference pins were driven into the subgrade, and surface disks were rolled into the asphaltic concrete when the top was laid. The remainder of the installation was completed after construction was finished. When not in use, a dummy top plate replaces the plate containing the transformer holder. When readings are to be taken, the dummy plate is removed and the transformer holder, complete with LVDT, is inserted in its place. In each test section provision is made for one total-deflection and one structure-deflection installation in each wheel path, and for one total-deflection installation mid-way between wheel paths.

Another device developed and used on the test for measuring deflection is known as the Benkelman lever-arm deflection indicator (Fig. 2). This is an extremely valuable instrument in that it may be used to measure the total pavement deflection at creep speed at any point—that is, it is not restricted to use at the location of elaborate instrument installations.

In operating the Benkelman indicator, a probe beam is inserted between the rear dual tires of a loaded truck or trailer. A foot on the front end of the probe rests on the pavement surface well ahead of the influence of the truck wheel. This beam is pivoted at the end of a reference beam which rests on three points on the pavement well back of the influence of the load. The truck is then moved ahead so that the loaded wheel passes the probe foot. An Ames dial measures the movement of the probe (and thus of the pavement surface) with respect to the reference beam.

Normal operation of truck traffic follows a known and reasonably constant pattern of transverse placements, depending on the width of the lane among other things. To simulate normal operation, it is necessary to instruct the test drivers to follow some definite sequence of transverse positions on the road. Lines were painted in color longitudinally along the pavement for use by the drivers as guides in keeping the wheels of their trucks at certain distances from the edge of the pavement. Since the job of driving these vehicles is monotonous, drivers may not remember which line to follow for each trip. It was therefore necessary to provide a means of reminding them. Mounted in the cab of each truck is a box with colored lights which change each time the driver is to change the transverse position of his wheels. Thus the color of the light in the box coincides with the color of the line on the pavement which the driver is to follow in positioning his wheels. The proper sequence for these code lights is established by a radio-activated, automatic stepping switch which moves up one position each time the truck completes a trip around the loop.

Cooperative Agencies

The WASHO Road Test is sponsored by the Highway Departments of California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Texas, Utah, Washington, and Wyoming. The right-of-way was furnished without charge by the State of Idaho, and after completion of the test the facility will revert to the state. Other cooperating agencies include the Bureau of Public Roads, which is contributing certain supplies, equipment, and personnel; truck manufacturers of the Automobile Manufacturers' Association, who furnished the tractors; trailer manufacturers of the Truck Trailer Manufacturers' Association, who furnished the trailers; and certain companies in the petroleum industry who are furnishing the gasoline, diesel fuel, oil, and grease consumed in the test. The total cost of the project is estimated at approximately $650,000.

As is its custom in operating a test of this nature, the Highway Research Board established an Advisory Committee made up of representatives of the above cooperating agencies, of the Department of Defense, of the National Highway Users Conference, of the American Trucking Association, and of certain pertinent departments of the Board. The committee also includes certain officials of the Board. The chairman is Earle V. Miller, M. ASCE, State Highway Engineer for the Idaho Department of Highways. This committee is considered by the Board as the final authority in all matters concerning construction and maintenance of the road and operation of the test.

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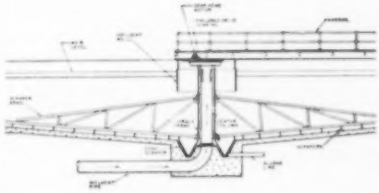

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Compacted-earth canal lining . . .

(This article begins on page 48)

(Continued from page 51)

tions was relatively small. For the earth-lined canal test section, the loss was fairly constant for the period of the test, whereas there was a decrease in the rate for the concrete-lined canal test section. Total loss from the earth canal was 15.7 acre-ft for 29 days over a reach of 2,904 ft, equivalent to 0.98 acre-ft per mile per day. For the concrete canal, the loss was 10.1 acre-ft for 24 days over a 2,949-ft reach, equivalent to 0.75 acre-ft per mile per day.

In comparing these rates, one should keep in mind the difference in size of the two canals, as shown in Fig. 2. This size differential is reflected in Table II, in which the difference in R_h is not compatible with the difference in S_h. In this table:

R = seepage rate, in cu ft per sq ft per 24 hours at 1-ft head (ft per day)
S = total seepage from test section, in cu ft per day (24 hours)
Subscript h = hook gage values

In the case of final readings, a 9 percent difference in R_h (from 0.0054 for the concrete to 0.0059 for the earth) produces a difference of 64 percent in total seepage (S). Actual amounts were 13,488 cu ft compared with 21,841.

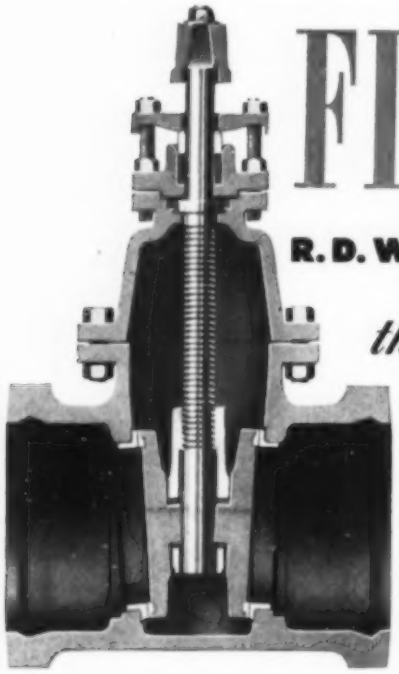
In general, laboratory percolation rates on undisturbed samples were higher for samples taken during construction in 1948 than for those taken in 1950. The magnitude of the seepage rate as determined by the Friant permeameters, or R_f, was lower for the tests made in the full canal than for the 1948 tests, but tests run in the unwatered canal (December 1950) produced rates closer to the values for the 1948 tests. These comparisons are shown in Table II.

The ratio of k (percolation rate) for undisturbed samples of natural ground to k for laboratory density varies between extremely wide limits. This is shown in Table I, a summary of percolation and permeability data taken during construction together with several ratios of these factors. Table I shows that this ratio (k-undisturbed to k-laboratory density) for the earth lining also varies between wide limits, but with this significant difference, that all values are smaller, indicating that the earth lining approaches laboratory conditions more closely than the natural ground did. If we plot frequency distribution diagrams of the two ratios (taking the liberty of using a logarithmic scale for the cell boundaries because of the great spread of values) we find that the diagram representing the earth-lining ratios is positioned to the left compared with the diagram representing the natural ground ratios (Fig. 5). Recalling that the values of the ratios are plotted logarithmically, the relative positions of the diagrams are significant.

Further study of Table I reveals that the statistics in general incline to favor the earth lining. Poor soils were removed and good compaction material placed in their stead; compactible soils were disturbed and compacted, where necessary and possible; and finally impermeable natural soils were left in their natural condition to form the canal banks.

The 1950 tests, made in representative reaches of the concrete-lined and earth-lined portions of the canal, showed a loss of 0.98 acre-ft per mile per day in the earth-lined canal, which compares favorably with 0.75 acre-ft for the concrete lining (based on total loss of water from the test sections). Either of these quantities represents a negligible loss from a canal of 5,000-cfs capacity.

Some figures comparing the cost of compacted earth lining with unreinforced concrete lining on Bureau of Reclamation irrigation canals are given in Table III.



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(*Continued from page 96*)

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CONSTRUCTION SUPERINTENDENT, resident engineer for contracting firm doing heavy construction on housing. Salary, $7,500–$10,000 a year. Location, eastern Pennsylvania. Y-8944.

COST ENGINEER OR ESTIMATOR, 35–45, engineering graduate with at least 10 years' practical experience as a cost engineer, preferably on hydroelectric projects. Will establish methods, train and supervise a small staff in the field to report and analyze the cost of each phase of a job and the estimated cost to complete; to report the physical completion of each phase of a job and to assist in the preparation of estimates, budgets or other work of a similar nature. Some traveling. Location, Brazil. F-8999.

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CATALOG DIGESTS of ENGINEERING and INDUSTRIAL interest

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Sauerman Bros., Inc.—Catalog G describes the many designs of tautline cableways developed by this company. Of particular interest is the bridle cable system for small cableways that eliminates the need for traveling towers. Paper on "Methods of Estimating Impact Factor in Design of Tautline Cableways" by C. H. Huebel will be enclosed if desired.

2 AERIAL MAPPING

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3 AERIAL PHOTOGRAPHY

Jack Ammann Photogrammetric Engineers—announces two new circulars, "370,000 Square Miles" and "Aerial Photography and Maps for City Planning." The former describes a new type of high altitude, low cost, precision aerial photography; showing coverage, available scales, sample reproductions, and prices for contact prints, mosaics, and enlargements. The latter attractively presents photogrammetric mapping as a tool for city planning and developments. The circular is beautifully illustrated with aerial photographs, planimetric and topographic maps, and emphasizes the advantages of photogrammetry in city planning, subdivision development, expressway locations, and tax assessments.

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Fairchild Aerial Surveys, Inc.—A comprehensive brochure explains the application of aerial photography, photogrammetry and airborne magnetometer surveys to engineering and geology. Entitled "Focusing on Facts," the booklet contains 28 pages of text and illustration for inclusion in your permanent files.

5 AIR-ENTRAINED CONCRETE

Autolene Lubricants Company—A new and enlarged edition of the Protex Modern Placement of Concrete fact book, has been recently announced. Published under the direction of Autolene Industrial Research Division, the edition contains the latest technical information and field use on air-entrained concrete. Complete with photographs of the latest concrete construction projects, the book is full of questions and answer information about air-entrainment technique and Protex Air-entraining solutions.

6 AIR METER CATALOG

Autolene Lubricants Company—A new, revised edition of the Protex Air Meter Catalog has just been released. The catalog, published under the direction of the Autolene Industrial Research Division, describes the use of a meter in the placement of air entrained concrete. A full description of the Protex Air Meter, its operation, and benefits of accurate control are given.

7 AIR POLLUTION SURVEY METER

Taller & Cooper, Inc.—has announced a new, portable carbon monoxide detector, sensitive to 50 parts per billion of carbon monoxide in air with full scale ranges of 1, 10, 100 and 200 parts per million selected by a simple range switch. The unit, 15 × 15 × 9 in. in size, and weighing about 75 lbs, contains its own sampling pump and plugs in to 115 volts A.C. power supply. A simple turn of a dial converts the unit into a mercury-vapor detector. The unit may also be modified to analyze for benzene, tetra-ethyl lead and other air contaminants.

8 AIR RELEASE & AIR INLET VALVE

Simplex Valve & Meter Company—Bulletin 1203 describes the functions of a new Type AV Combination Air Release and Air Inlet Valve. This valve was designed for the purpose of providing a small instrument having the functions of releasing automatically air accumulations from systems, admitting air to systems for the purpose of breaking vacuums within them and venting large quantities of air when filling systems with water.

9 ALTIMETERS FOR MAPPING

Wallace & Tiernan—The successful use of altimeters transported by helicopter for vertical control of multiplex mapping is described by Col. R. R. Robertson in "Altimeters as used by the 30th Engineers for Mapping." The two-base method proved best and bases were separated as much as 30 miles horizontally and 7,000 ft vertically. Altimeter runs included 69 points of known elevation which were checked within 8 ft. Criteria for satisfactory altimetry conditions and for accepting altimetry elevations are given.

10 ANCHOR FLOOR PLATES

Armco Drainage & Metal Products, Inc.—has issued a 4-page illustrated folder on its Stelcon anchor floor plates. It details such features as rugged construction, low maintenance, safety, more efficient materials handling, and economy of installation and use. Photographs of typical industrial installations are shown, and other proved applications are listed.

11 ARC WELDING

The Lincoln Electric Company—offers studies in structural arc welding, issued periodically; current series presents an analysis of the design of a welded rigid frame building, typical of design used for warehouses, plants, churches, auditoriums, markets, etc. Building is 60 ft by 150 ft, 24 ft high at the center. Design is flexible as to size of building and is unusual in that metal roof decking is used to give longitudinal rigidity without the aid of auxiliary purlins. Comparative analysis made to illustrate advantages.

12 ASPHALT PLANT CATALOG

Barber-Greene Company—A 36-page two color catalog describes the Barber-Greene 848 Series of asphalt plants and their components. There is a flow chart of a high-type asphalt plant showing the various functions of each component unit relative to the overall plant operations. All types of asphalt plant set-ups are featured, such as: cold aggregate controlled, stabilization, travel plant, etc. Feeders, hoppers, gradation unit, mixer, dust collector, and dryer are described and illustrated as individual units as well as their numerous combinations.

13 AUGER DRILLS

The Salem Tool Company—has issued general bulletins covering complete line of McCarthy Auger drills. Trench type utility auger drills; truck-mounted and self-propelled horizontal high-wall drills; vertical 6 in. and 8 in. auger drills; and coal recovery drills, as well as special bulletins covering their trench type utility drill for boring holes under streets and highways for placing gas and water pipe as well as electric conduit are available. The McCarthy vertical drill is widely used for exploration purposes as well as shot hole drilling for blasting of overburdens.

There are 179 Digest items on pages numbered 100 to 120. Read all items for the literature of interest to you.

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31	32	33	34*	35*	36	37*	38	39	40	41	42	43	44	45
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NOT GOOD AFTER November 15, 1953, for readers in the U.S., but requests will be accepted to December 30, 1953, from readers outside of this country.

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CATALOG DIGESTS

14 BELT CONVEYOR IDLERS

Link-Belt Company—covers more than 500 belt conveyor idlers, in 34 types, in Book No. 2416. Idlers of the 20-deg troughing type for light, medium and heavy duty service, two styles of 45 deg idlers, flat belt, belt training, rubber cushion and variable troughing idlers are shown, all in a broad range of roll diameters and belt widths, together with return belt idlers. Detailed information is provided for selection and spacing, based on weight and lump size of material to be conveyed.

15 BITUMULS—TYPES AND USES

American Bitumuls & Asphalt Company—has a 24-page, two color booklet, "Bitumuls for Maintenance" which is a fully-illustrated, valuable guide to modern methods, materials and equipment for the repair and maintenance of existing pavements. It covers the use of various types of emulsified asphalts with a wide range of aggregates.

16 BLUEPRINT MARKING PENCIL

American Lead Pencil Co.—New brilliant colors in the Venus color pencil line for marking on blue or white prints. 54% stronger—sharpens to a sharp needle point and holds it. 27% greater markability—brilliant clear marking—waterproof, too!

17 BOLTS FOR STRUCTURAL JOINTS

Bethlehem Steel Company—There's a marked and growing trend toward the use of bolts instead of rivets in erecting steelwork. In a 16-page booklet, "High Strength Bolts For Structural Joints," the economies and other advantages of erecting steelwork in this way are set forth, together with specifications for assembly and other useful information.

18 BORINGS

Raymond Concrete Pile Co.—A booklet "Subsoil Investigations for Foundations," catalog B-4, explains the reason for subsoil investigations, what Gow borings are and how they are made, and results obtained. Illustrated are methods for making borings and taking samples, and various types of rigs in operation.

19 BRONZE CASTING ALLOYS

American Manganese Bronze Company—A 48-page booklet, called "Reference Book on Bronze Casting Alloys," gives general information on composition, characteristics, and applications of many of the common or typical alloys. It has an index of specifications for common kinds of bronze castings; and an index of applications and characteristics of bronze alloys in cast form.

20 BULK MATERIALS HANDLING

Sauerman Bros., Inc.—Catalog E describes various sytems for handling bulk materials in and out of storage with drag scraper and other machines operated by one man for any desired capacity. The drag scraper picks up material, reclaims or stocks out, dumps, without use of any supplementary equipment, works over longer spans.

21 BUSINESS AND TECHNICAL GUIDE

McGraw-Hill Book Co.—offers a special catalog devoted to recent publications covering various phases of civil engineering. Complete, clear descriptions are given on books dealing with hydraulics, cost estimation, concrete, foundations and structures, soil mechanics, mathematics and allied subjects. Written by experts in the field, these books contain the facts, experience, data needed in solving your particular problems.

22 CARBON BLACK DISPERSION

A. C. Horn Company, Inc.—A 6-page Brochure on AE Dispersed Black, a scientifically formulated carbon black dispersion, used for the darkening of air-entrained or regular concrete in either monolithic or topping construction, is available. It gives detailed test data, uses and recommendations required under varying conditions. The treatise should be of considerable interest to highway engineers, concrete specialists and consultants, contractors and ready-mix plant operators.

with Pressure-Creosoted Piles

• Approximately 139,400 linear feet of pressure-creosoted piles were used in the foundation of Breukelen Houses, a Federal Aid housing project constructed by the New York City Housing Authority.

Ten of the project's thirty apartment buildings were located on filled-in ground over old water courses. Pressure-creosoted piles were considered the most practicable type of foundation for these 6- and 7-story structures. Over 3,100 25-ton capacity piles, ranging in length from 27 to 64 feet, were used at a cost of $261,758.00—a very reasonable cost for permanent piles.

The Breukelen project, covering a total area of 64.9 acres, will house 1,595 families. The Horn Construction Co., Inc., of New York City, was general contractor for foundations. The piles were driven by I. B. Miller Contracting Corporation of Queens. Severud-Elstad-Krueger of New York City were structural engineering consultants.

Koppers Pressure-Creosoted Foundation Piles are considered permanent construction when cut off above the water table and the tops saturated with creosote and capped in concrete. For information on price and delivery, ask your nearest Koppers office or write:

KOPPERS COMPANY, INC.
WOOD PRESERVING DIVISION

KOPPERS PRESSURE-TREATED WOOD

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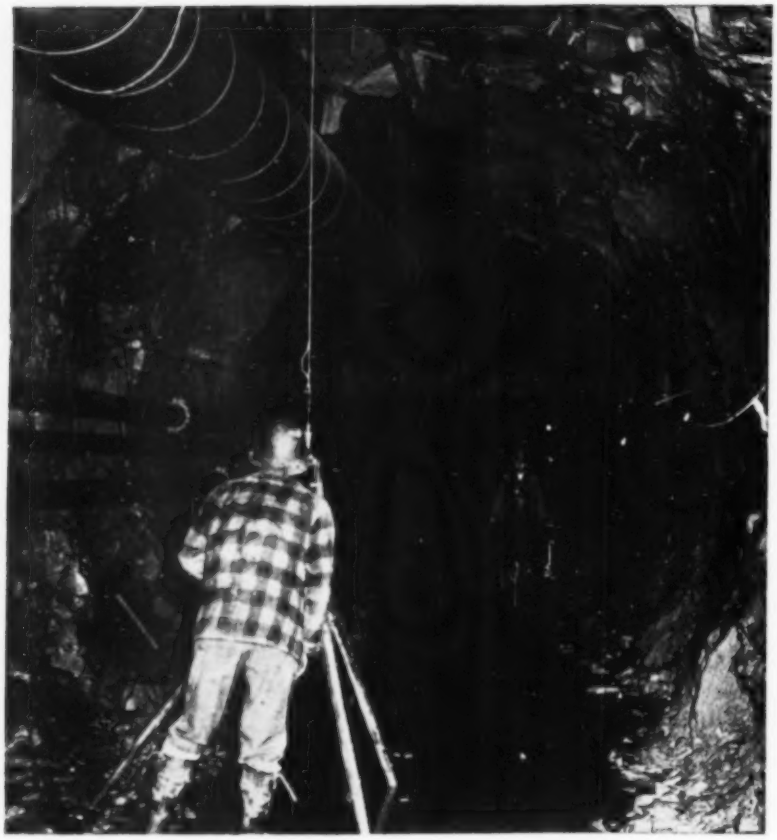

When you want to deliver air to underground diggings, you can depend on Naylor light-weight pipe for uninterrupted service. This distinctive lockseamed spiralwelded pipe gives you lines that are easy to handle and install, particularly with Naylor Wedge-Lock Couplings to speed connections. Naylor Pipe is extra-strong, safe, leaktight, making it ideal for push-pull ventilation. Sizes from 4″ to 30″ in diameter. Write for Bulletins No. 507 and No. 514.

NAYLOR PIPE COMPANY
1281 East 92nd Street, Chicago 19, Illinois
New York Office: 350 Madison Avenue, New York 17, New York

CATALOG DIGESTS

23 CAST-IN-PLACE PILES

Eastern Concrete Pile Co., Div. of C. L. Guild Construction Co., Inc.—has a descriptive folder on the COBI cast-in-place concrete piles. It illustrates how the piles are driven, poured, and tested. The corrugated spiral shell is driven by a pneumatic mandrel expanded with 125 psi pressure. The company points out that the piles screw themselves into the ground, resisting both settlement and unlift. Another folder is available, which describes the use of the COBI pile on the New York Thruway.

24 CHEM-O-FEEDERS

℄ Proportioneers, Inc. ℄—Bulletin describes application of chem-o-feeders for chlorine dioxide, hypochlorite, and chemical feeding to municipal and private water supplies, sewerage treatment, and swimming pools. Exclusive "See-Thru" reagent heads permitting visible inspection of all moving parts in contact with chemical solution, corrosion resistance, and ability to operate under high pressure are some of the advantages discussed.

25 CLARIFIERS

Infilco Inc.—Bulletin 850-A describes how the "Cyclator" is designed to combine in one unit all functions, both chemical and physical, for complete treatment of a wide range of industrial wastes, especially those containing large amounts of light suspended solids or those which produce voluminous sludges.

26 COLD FEED BULLETIN

Barber-Greene Company—A 16-page, two-color folder describes a wide variety of cold feed methods, adaptable to all makes of asphalt plants, regardless of make or manufacture. Four-bin feeders; two-, three- and four-bin hoppers; apron, belt and reciprocating feeders; both portable and permanent belt conveyor installations; tunnel conveyors and car unloading equipment are some items featured. This booklet suggests ways of increasing asphalt plant production by eliminating shutdown due to aggregate deficiencies and by avoiding extra handling of spillage.

27 CONCRETE

The Master Builders Co.—A 12-page booklet entitled, "A Quiz On Concrete," shows by means of charts and data why Pozzolith, cement-dispersing, water-reducing, air-entraining agent is a positive aid in obtaining: required strength most economically; required workability most economically; minimum shrinkage; low permeability; maximum bond of concrete to steel; and maximum durability. It also gives suggestion specifications for concrete.

28 CONCRETE ADMIX

American Bitumuls & Asphalt Company—A 4-page leaflet, "Pittsburgh Testing Laboratory Report on Hydropel, An Integral Admix for Waterproofing Concrete" as compared to other admixes is offered. Reproductions of the actual test reports from this independent laboratory, combined with explanatory graphs, charts, photographs and summaries, show the superiority of Hydropel concrete in resistance to water absorption.

29 CONCRETE COLUMNS

Sonoco Products Co.—has a detailed booklet containing design data for reinforced concrete columns from 8 in. to 36 in. ID. Also available, technical data on Sonotube fiber forms for circular concrete columns and piers.

Please remember industrial literature is costly. It is requested that you ask only for those booklets of particular interest to you.

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CATALOG DIGESTS

30 CONCRETE CONSTRUCTION ACCESSORIES

Superior Concrete Accessories, Inc.—Catalog 500 has 56 pages on accessories for concrete construction. Form ties and clamps are grouped by class of construction: for ordinary foundations, for water tight walls, for engineering structures and tilt up slab construction. There is also a section devoted to special products often required in concrete construction. Tables of concrete pressures in forms at summer and winter temperatures, recommended safe spacings of form ties grouped by sizes of form lumber and safe tie capacities are given in an insert at the back of this catalog.

31 CONCRETE CURING COMPOUNDS

Servicised Products Corporation—A concrete curing compounds circular describes three basic types of Servicised concrete curing compounds, their uses and provides application information.

32 CONCRETE PAVEMENT DESIGN

Portland Cement Association—An 86-page edition simplifies and expedites design procedure for roads and streets carrying all classes of traffic. Eighteen pavement design charts have been reduced to four covering a somewhat wider range. This manual for the practicing engineer includes design charts for tiebars and dowels, an expanded section on subbases, two pages of joint details and a simplified procedure for determination of "controlling wheel load."

33 CONCRETE PIPE

Lock Joint Pipe Company—has a catalog covering the design and manufacture of all types of Lock Joint concrete pressure pipe and a pamphlet giving complete instructions for the installations of all types and sizes of the pipe. Both pamphlets are liberally illustrated with photographs and technical drawings.

34 CONCRETE PIPE FOR IRRIGATION AND DRAINAGE

American Concrete Pipe Association—An official publication has just been released and is available to engineers. Contains information on design of irrigation pipe lines, construction of irrigation pipe lines, methods of irrigating with concrete pipe lines and descriptions of various irrigation projects. This book is priced at 70¢.

N. B. There is a charge for this book. Make checks payable to the American Concrete Pipe Association.

35 CONCRETE PIPE HANDBOOK

American Concrete Pipe Assoc.—A handbook contains 384 pages on the manufacture and use of concrete and reinforced concrete sewer and culvert pipe. Discussion of Marston's Theory and maximum and minimum allowable depths of fill is presented along with examples and tables. Useful hydraulic data and information on jacking pipe lines is given. A thorough, comprehensive discussion of the use of concrete pipe in sewers and culverts is included. Appendix contains A.S.-T.M. and AASHO specifications. Price $4.00.

N. B. There is a charge for this book. Make checks payable to The American Concrete Pipe Association.

36 CONCRETE PRODUCTS

Universal Concrete Pipe Company—Standard and custom-made concrete products of the company's 26 plant network are described in a folder. Products illustrated are plain and reinforced concrete sewer pipe, culverts, site cast pipe, large diameter pipe, long length pipe, special pipe for carrying corrosive industrial wastes, flat base pipe, rubber gaskets, river weights, precast package bridges and concrete cribbing.

37 CONCRETE REINFORCING DESIGN HANDBOOK

Concrete Reinforcing Steel Institute—has a unique, 412-page manual, offering finished design data for every principal type of reinforced concrete building member—already worked out in tabular form. No formulas or calculating needed—just apply load and span requirements to the appropriate table and read off complete data. Indispensable for engineers, designers and architects. Follows current codes and practices. Price is $5.00 per copy.

N. B. There is a charge for this book. Make checks payable to the Concrete Reinforcing Steel Institute.

38 CONSTRUCTION DETAILS FOR FORMS

Symons Clamp & Mfg. Co.—Three new sheets giving the construction details for their high strength panel form, light construction panel form and all wood panel form are available. Each sheet gives exact measurements of their 2 ft by 8 ft panel, 12 in. by 8 ft filler, 2 in. by 8 ft filler and inside corner. Also included is step by step construction procedure and a hardware requirements schedule.

39 CONVEYING AND MIXING EQUIPMENT

Link-Belt Company—Conveying and mixing equipment for chemical flocculation at water, sewage and industrial waste treatment plants is described in Book No. 2442. Two types of mixers are shown for rapid and slow mixing operations, together with conveying and elevating equipment for economical handling of bulk or packaged chemicals. Tested layouts and selection tables to aid in determining suitable tank size for required circulation flow are included.

40 CRANE

Pitman Manufacturing Company—has a bulletin on the new Pitman Crane, Model 80. Many time-saving, cost-cutting features are presented and photographs, specifications and capacities are listed.

41 CRANE-EXCAVATOR

Wayne Crane Division, American Steel Dredge Company, Inc.—An 8-page catalog in color illustrates the heavy-duty Model 66 crawler-mounted crane-excavator. The catalog is entitled, "Meet the Heavyweights" and features many shots of Wayne Crane crawlers in action. Also illustrated are many of the features which have proved to be outstanding money-savers for Wayne Crane owners. These include simplified deck machinery layout, oversize drums and clutches, and extra-heavy rugged crawler construction. Complete specifications, operating data and lifting capacities are included.

42 CRAWLER TRACTOR

Caterpillar Tractor Co.—"The New D8 Pusher" is the title of a broadside recently published. Complete with illustrations, including a detailed cut-away drawing of the new oil-type clutch, the broadside describes application of the D8 to push-load in tandem by using a C-frame and push block. Speed and economy in getting scrapers loaded are stressed in reporting on the versatility of the Cat D8 crawler tractor. A detailed specification sheet is included.

43 DIESEL CRAWLER TRACTORS

International Harvester Company—presents individual product catalogs covering each of the five International industrial diesel crawler tractors, TD-6, TD-9, TD-14A, TD-18A, and TD-24. Two of the above models are also available with carbureted engines, T-6 and T-9. A special catalog illustrating crawler tractors in pipe line operations can be obtained upon request.

44 DIESEL ENGINES

Nordberg Manufacturing Company—offers Bulletin 194A on the 4FS diesel engines, made especially for the small power user with all the fine engineering and precision construction that goes into the larger Nordberg diesels. Special features, photographs, specifications, construction features, applications, etc., are included.

45 DIESEL POWER UNITS

International Harvester Company—Information on six models of International diesel power units, the UD-6A, the UD-9A, UD-14A, UD-16A, UD-18A, and UD-24 is contained in a catalog entitled "International Diesel Engines and Power Units." A second catalog entitled "International Gas Gasoline or Distillate Engines and Power Units" covers the five International carbureted power units, U-1, U-2A, U-4, U-6, and U-9. Also available is a catalog illustrating International power units in oil field pumping operations.

46 DIRECTION FINDERS

Bludworth Marine, Div. of National-Simplex-Bludworth, Inc.—Radio direction finders and radar for offshore position location. Nine models available to suit your needs. Literature and prices on request.

47 DOCKS, WHARFS AND PIERS

De Long Engineering & Construction Co.—Brochure describes the fabricating, towing and erecting operation of the De Long dock. This steel dock fabricated in efficiently operated fabricating or ship building plants or yards in various parts of the world and towed to site of final location is erected in a matter of several days ready for berthing ocean-going ships. Permanent or temporary erections. Brochure illustrates installations of 50 ft by 1000 ft dock for army north of arctic circle and permanent 82 ft by 1130 ft ore and cargo handling dock on Orinoco River, Venezuela.

48 DOORS

The Kinnear Manufacturing Co.—The catalog and data book discusses fully and illustrates the advantages, the economy, the construction features, and the general specifications of the various types of wood and steel upward-acting type doors. Known as Bulletin 75, it gives information on installation clearance requirements, methods of operation and controls, as well as adaptability of the doors for many types of uses.

49 DOUBLE TUBE CORE BARREL

Sprague and Henwood, Inc.—Bulletin No. 330 contains more information regarding the Series "M" double-tube core-barrel than has heretofore been available in print and should be interesting to those concerned with diamond core drilling. Developed originally by the company to permit securing a high percentage of good core from fractured, porous or soft formations than would otherwise be possible, it has since been adopted as standard by the Diamond Core Drill Manufacturers Association.

50 DOUBLE-X MECHANICAL JOINT PIPE

The American Cast Iron Pipe Company—manufactures Mono-Cast centrifugal pipe in diameters 3 in. to 48 in. inclusive. Among the joints offered with this pipe is the American Double-X Mechanical Joint. A booklet describing this product gives dimensions, weights and metal thicknesses. The booklet contains 44 pages and is illustrated.

51 DRAFTING PENCIL

Eagle Pencil Company—offers specific proof of needle point strength and durability, plus a sample Turquoise Drawing Pencil for your own test at your drafting board.

52 DRAWING INSTRUMENTS

Borden and Riley Paper Co., Kern Drawing Instrument Division—A brochure offers a description of the precision drawing instruments, kits and individual pieces, manufactured by the renowned Kern & Co., Ltd., of Aarau, Switzerland. The brochure is profusely illustrated and reflects the latest technical advances that are embodied in every Kern kit and instrument.

53 DREDGES

Yuba Manufacturing Company—has prepared a 42-page booklet describing Yuba bucket line dredges and their use in the placer mining and excavating industries. A copy of the booklet will be mailed upon request and extra copies will be furnished to *libraries and universities* particularly interested.

54 EARTH DIGGER

Acker Drill Company, Inc.—offers a four-page bulletin describing the Acker Earth Digger which is ideal for soil sampling or speedy digging of holes for setting telephone poles, guard rails and fencing. Unit can be jeep or small truck mounted.

55 ECHO DEPTH RECORDER

Bludworth Marine, Div. of National-Simplex-Bludworth, Inc.—A specification sheet describing Model ES-123 Supersonic Echo Depth Recorder is offered. This instrument provides a permanently recorded graph of underwater contours as well as an indication of the constituency of bottom materials. Underwater survey groups, dredging companies, bridge builders and underwater pipeline companies will find this equipment most interesting.

All these changes made

without one line of retracing

- *substitute new title block here*
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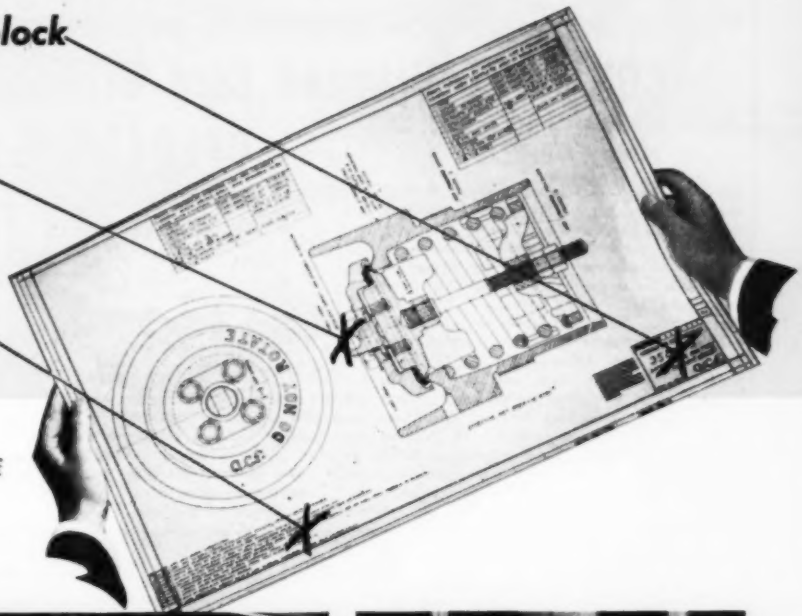
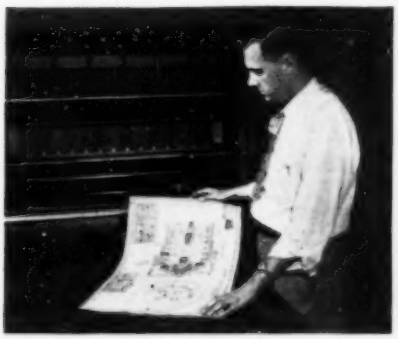
- *delete shop notes and lot numbers*



The American Car and Foundry Company, at its Milton, Pa., plant, has to modify hundreds of drawings like the one shown here to meet Army Transportation Corps requirements. Retracing would be much too slow . . . much too expensive. But how else can the job be done? *Kodagraph Autopositive Materials are the welcome answer!*



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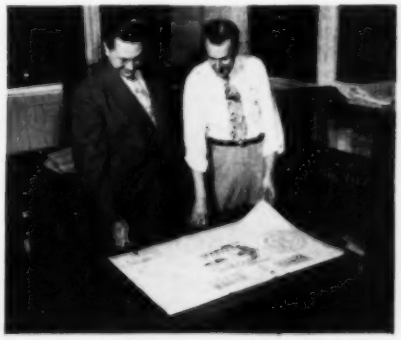

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CATALOG DIGESTS

56 EFFECTS OF CALCIUM CHLORIDE

Solvay Process Div., Allied Chemical & Dye Corp.—has prepared a 40-page, semi-technical booklet of interest to architects, engineers and others concerned with specifications, design or production of Portland cement concrete. This booklet contains tables, graphs and charts covering setting time, early strength, curing, slump, density, surface wear, shrinkage, and ultimate strength. Also shown are effects of varying temperatures and cold weather, and the results with special cements including air entraining, high early strength and low heat cements.

57 EFFLORESCENCE

Western Waterproofing Company—has an 8-page, authorized reprint of an analysis of factors contributing to efflorescence phenomena. The ASTM Bulletin, No. 185 was written by F. O. Anderegg, Consulting Specialist on Building Materials Research.

58 ELLIPTICAL VENTURI TUBE

Simplex Valve & Meter Company—A 5-page brochure has been prepared to describe the Type VE Venturi Tube. This tube is a primary device used to produce pressure differentials from flowing liquids for the purpose of actuating rate of flow meters. Data is given as to how any low-velocity, low-pressure flow of liquids, containing solids, can be measured in connection with a venturi meter.

59 ENGINEERING INSTRUMENTS

W. & L. E. Gurley—An illustrated 64-page catalog, No. 50, describes the complete line of Gurley engineering instruments. Description and specifications of several types of transits, levels, alidades, leveling and stadia rods, and plane tables with accessories are listed. Dip needle, cruising and geologists compasses are included, as well as current meters, water level recorders and wind instruments.

60 ENGINEERING TEXTBOOKS AND REFERENCES

The Ronald Press Company—Described in a special brochure are a selected list of current technical books of special interest to the engineer. These authoritative and up-to-date references and textbooks cover many important aspects of structural analysis, design, model testing, and management.

61 EQUIPMENT

Austin-Western Company—A 12-page catalog, AD-2146, covering the company's line of equipment is available. This includes descriptions and pictures of the various sizes of power graders and their attachments, street sweepers, 3-wheeled and tandem rollers, the Badger convertible shovel and the complete line of crushing, screening and washing equipment.

62 EXCAVATORS AND CONVEYORS

Sauerman Bros, Inc.—Catalog A, "Power Drag Scrapers" describes long range-handling of earth, clay, broken rock and other bulk materials at low cost. Catalog C, "Slackline Cableway Excavators" has 28 pages, telling you about a machine which digs, hauls, elevates, and automatically dumps all in one motion. Catalog G, "Tautline Cableways" shows how they are used to hoist and convey 1-ton to 25-ton loads on bridge, dam and filtration plant construction jobs. Catalog J, "Scraper Buckets" is a detailed summary of standard types plus some specially designed buckets used with drag scrapers.

63 FACILITIES AND PRODUCTS

Newport News Shipbuilding and Dry Dock Co.—A 42-page, two color booklet illustrates the great variety of heavy industrial equipment produced by the company, and the wide range of facilities used to produce them. This booklet is of particular interest to concerns seeking appropriate facilities for the production of heavy industrial equipment.

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64 FILTER EQUIPMENT

Infilco, Inc.—Bulletin 1560-B includes technical data and description of the Stellar Filter for filtering through diatomite or other filter-aid without the use of coagulants. The Stellar Filter is designed to treat 300 gph to several thousand gph.

65 FIRE EXTINGUISHING EQUIPMENT

Walter Kidde & Company, Inc.—Bulletin P8R5 describes all types of portable fire extinguishers for Class A, B, and C fires. The brochure also outlines smoke and temperature-rate-of-rise fire detection systems as well as automatic carbon dioxide extinguishing systems for machinery and entire rooms.

66 FLOODLIGHTING PLANS

General Electric Company—NEMA-authorized engineering information. Designated as bulletin GET-1284C, the publication includes complete layouts and specifications for all types of recreational facilities, including lighting diagrams for swimming pools, tennis, baseball, golf-driving ranges, racetracks, and the like.

67 FLOOR GRATING

Borden Metal Products Co.—A catalog containing technical information on how to select, design, purchase and install floor gratings, safety steps, floor armor is offered. Safeload tables, step-by-step procedure for ordering, planning and checking, etc., is included.

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68 FLUORIDATION

G. Proportioneers, Inc.—Bulletin SAN-9 gives the complete story on the feeding of fluorides for the reduction of dental caries. It explains the methods of feeding sodium silico-fluoride and hydrofluoric acid under pressure. Special attention is given to the accurate control of feeding in strict proportion to the flow. Equipment is described for feeding into pressure line.

69 FORM ERECTION

Symons Clamp & Mfg. Co.—announces the availability of its latest 4-page bulletin "How to Erect the Symons Forming System." Erecting and stripping advantages are explained in a short, factual manner. The System and what it consists of, is described, including—panels, corners, pilasters, and fillers, waler tie, tightening wedge, short connecting bolt, two way form tie and long connecting bolt. Detailed information is given on the high strength panel, light construction panel and all-wood panel. In addition, page 4 is devoted to important facts about the erecting and care of Symons forms and factors that will affect concrete pressure.

70 FOUNDATIONS

Drilled-In Caisson Corporation—Literature describes foundation columns anchored in rock sockets; heavy column loads carried on single caissons; penetration through any type of soil to rock at any depth; examination of rock can be made; economy in time and labor; foundation bonded in rock; description, design, specifications, technical data.

71 FOUNDATIONS AND HEAVY CONSTRUCTION

Spencer, White & Prentis, Inc.—has literature on the construction of difficult and unusual foundations, description of concrete-filled steel tubes driven to rock, including technical data, performance and installation, description of Pretest Underpinning and the application of the Pretest Method to construction other than foundations; Pretest foundations; caissons; foundations under existing buildings; shoring and moving buildings.

72 GATES CONTROL WATER LEVELS

Thompson Pipe & Steel Company—A bulletin shows how two new, simple automatic gates control and maintain accurate water levels either above or below gates for streams and canals, water and sewage plants and other open-channel uses—at considerable less cost than conventional automatic gates. New design principle. A third device maintains uniform discharge with varying head on upstream side. The bulletin illustrates many typical uses to save water, lower maintenance costs and eliminate flood damage. Design and installation diagrams are included.

73 GENERAL LINE

Allis-Chalmers Manufacturing Company—A 28-page three color general line catalog of the company's industrial crawler and wheel tractors, motor graders, power units, allied equipment accessories, and attachments is available. Illustrations are in color and brief descriptions and specifications tell about each model.

74 GRATING-FLOORING AND TREADS

Irving Subway Grating Co., Inc.—Catalog F-225 contains illustrations, descriptions and engineering data on grating flooring, treads and floor armoring (riveted, press-locked, welded types)—safe, durable, fireproof, ventilating, clean and economical—for industrial and power plant and refinery walkways, stairways, driveways, trucking aisles; ship cat-walks and engine room floors and treads; locomotive, freight and passenger car runways and treads; roadway armoring, expansion joints, catch basin covers; bridge decking.

75 GUNITE

Pressure Concrete Company—has a 48-page illustrated, free booklet on Gunite in all of its phases. The booklet contains specifications, job stories, and illustrations showing Gunite repair of reservoirs, dams, filter plants, sewage disposal plants, stadiums, bridges, stacks and bunkers. The booklet also contains photographs on new prestressed tank construction and much other data. A new leaflet just published illustrates pressure grouting to dams.

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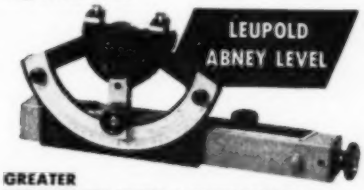

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CATALOG DIGESTS

76 HEAVY DUTY MOTOR OILS

Standard Oil Company (Indiana)—A 12-page illustrated booklet covering the history and development of Standard's heavy-duty motor oils is available. This bulletin reviews the performance requirements of heavy duty motor oils and defines the new A.P.I. service classifications.

77 HIGHWAY STRUCTURES

American Association of State Highway Officials—offers Standard Specifications for Highway Bridges, 6th edition, 1953. In keeping with policy of frequent revision in order to incorporate all current developments, the Committee on Bridges and Structures of the American Association of State Highway Officials has completed the new volume published by the Association. This book is accepted throughout the world as a leading treatise on highway structures. Every design engineer should have this publication. Price is $4.00 each.

N. B. There is a charge for this book. Make checks payable to American Association of State Highway Officials.

78 HOISTING MACHINERY

Superior-Lidgerwood-Mundy Corporation—Bulletin H-414 describes and illustrates a full range of steam, electric, gasoline and diesel-powered hoisting machinery built in standard sizes. Complete information given relative to drum sizes, line pulls, horsepower ratings, weights, etc. This bulletin also includes boom swinging gears and special data—how to figure rope capacities of drums, how to figure carpuller and capstan loads, which can be handled by hoists using various parts of load lines, and various lead lines.

79 HYDRANTS AND GATE VALVES

R. D. Wood Co.—A 22-page booklet, "Mathews Modernized Hydrant," gives detailed description of its various features, with numerous photographs and sectional views to clarify the text. Appropriate space is devoted to the removable barrel containing all the working parts, to the completely revolving head, and to the Sand-Spun protection case. A portion of this booklet is an illustrated treatment of gate valves that stay reliable under severe service conditions.

80 HYDRAULIC DATA BOOK

Leupold & Stevens Instruments, Inc.—Interpretive data on water measurement and control is at your fingertips in the 144-page revised edition, in three parts: Float Wells and Instrument Shelters; Errors in Float Operated Devices; Hydraulic Tables; plus pages for notes and memorandums. Indispensable for the engineer with its wealth of information, tables, charts and illustrations. The price is $1.00.

N. B. There is a charge for this book. Make checks payable to Leupold & Stevens Instruments, Inc.

81 HYDRAULIC TRUCK CRANE

Pitman Manufacturing Company—has a booklet on the Hydra-Lift, the new low-cost hydraulic truck crane. It tells what the Hydra-Lift is, how it works, how others are using it, and how it is installed. Numerous photographs, a capacity chart, dimensional drawings and specifications are included.

82 INCINERATOR STOKERS

Flynn and Emrich Company—Bulletin No. 1701 fully describes a proven design of automatic stokers for municipal and industrial incinerators. The bulletin clearly shows the design and operation of this simple, rugged and dependable incinerator stoker that has proven itself in the field.

83 INDUSTRIAL INFERENTIAL METER

Simplex Valve & Meter Company—Bulletin 500 contains data on operation, construction, accuracy, primary devices, and other general information of interest to power, process and sanitation engineers who deal with fluid flow problems. This instrument provides a means of obtaining very accurate measurement of fluid flows over remarkably wide ranges and is designed for water, sewage, sludge and industrial liquors.

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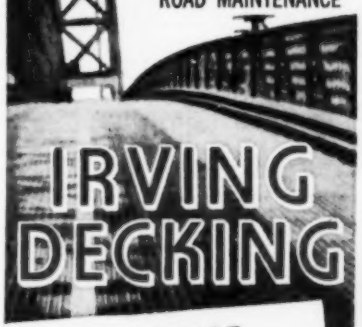

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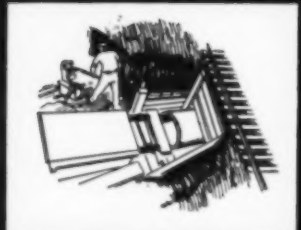

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CATALOG DIGESTS

84 INDUSTRIAL STORAGE SYSTEMS

Marietta Concrete Corp.—offers a catalog on modern industrial storage systems, designed to meet specific needs of diversified industries. More than just a silo or tank, these systems are complete storage and materials-handling installations engineered to improve handling facilities, help build reserves, and lower operating costs. There are sections on foundations, roofs, walls, floors and shelves. Photographs, illustrations, details of storage system construction, a capacity chart, etc., are included.

85 IRON & MANGANESE REMOVAL

The Permutit Company—Bulletin 3849 takes cognizance of the fact that iron and manganese are considered to be two of the most troublesome elements found in natural water supplies. Throughout this 8-page bulletin, four methods of economical treatment utilizing aeration, oxidation, and ion exchange resins are thoroughly described and illustrated for the removal of these harmful water impurities.

86 JOINT FILTERS & COMPOUNDS

Servicised Products Corporation—Servicised Products for pre-cast and tilt-up concrete construction describes Servicised Cementone rubber joint filler and Servicised curing and separation compounds for tilt-up and pre-cast concrete construction.

87 JOINT FILLERS AND SEALS

Servicised Products Corporation—A catalog gives complete details and specifications on joint fillers, hot-poured Para-Plastic sealing compound, premolded Para-Plastic, molded rubber waterstops, corrugated closure strips, sewer joint seals, rail filler, Calk-Crete sealing compound, and safety stair treads.

88 LETTERING MACHINE

Ralph C. Coxhead Corporation—The Vari-Typer engineering lettering machine relieves draftsman from tedious hand lettering. The machine operates like a typewriter, but has instantly changeable type faces in different styles and sizes to meet the various needs of the tracing or bill of material. The carriage is designed to hold tracings as much as 6 ft or more in width. The type impressions are electrically controlled producing a uniform, sharp, black character so important to a good tracing. Mathematical symbols as well as draftsmen style lettering is available in the changeable type for cartridge.

89 MASONRY CEMENT

Lone Star Cement Corporation—A 16-page, illustrated booklet outlines the advantages of Lone Star masonry cement in simplifying the problem of obtaining uniformly high-quality mortar, as well as the economy of one rigidly standardized, ready-to-use cementing material instead of two with no lime or portland cement to add, and no soaking or slaking. It provides timely information on soundness, low absorption, high water repellency and other factors contributing to durable, weather-resistant performance. Contains easily-read graphs showing effect of mix proportions on water retention, strength and absorption, effect of mixing time on water retention, etc., along with convenient reference tables for estimating quantities.

90 MATERIALS HANDLING EQUIPMENT

Link-Belt Company—Materials handling and preparation machinery for sand, gravel, stone plants is described and illustrated in Book No. 2126. It covers all types of elevators and conveyors; a full line of vibrating and revolving screens; various types of washing and dewatering units; mobile shovels, cranes, draglines; fluid drives, chain drives, enclosed gear drives, variable speed drives. There are many photographs and diagrams, with tables of dimensions, weights and other information essential to laying out a new mechanical handling or revolving job, or modernizing an existing installation.

91 MEASURING FLUMES

Thompson Pipe & Steel Company—Self-cleaning Parshall measuring flumes give permanently accurate water measurement for open channels as described in bulletin. Used in water, sewage and industrial plants as well as for irrigation. Presents advantages and also complete table for free flow discharge of throat widths from three inches to twenty feet. Bulletin shows how these flumes stop water disputes and meet with approval of State Engineers.

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CATALOG DIGESTS

92 MEASURING TAPES & RULES

The Lufkin Rule Company—A 96-page catalog describes measuring tapes and rules for engineers that are manufactured by the company. Special measuring tapes used in mining and oil, as well as engineer's frame and case tapes, are covered. Not only are steel and woven measuring tapes described, but also the new Hi-Line non-metallic tape which is woven from the newest fibers developed by science.

93 MECHANICAL PIPE JOINTS

R. D. Wood Co.—A 4-page leaflet describes mechanical joints that meet the requirements for permanent tightness of pipe joints under conditions of deflection, expansion, contraction and vibration. They are designed for high-pressure lines for oil, gas, water, steam, or chemicals.

94 METRIC WALL CHART

Mayo Tunnel & Mine Equipment—has a metric wall chart for the rapid conversion of meters to feet and inches. This is available to those engineers who work with the metric system.

95 MOBILE MIXING UNIT

Hetherington & Berner, Inc.—Bulletin MP-51, offers complete details on the Moto-Patcher, a mobile mixing unit designed for easier, more economical road and street maintenance. Photographs, specifications and a moto-patcher flow diagram are included.

96 MOTO-PAVER

Hetherington & Berner, Inc.—The Moto-Paver which provides a new and more efficient method for cold mix bituminous construction is described in Bulletin MP-49. Construction and operating features that make the Moto-Paver outstanding for dependable, economical performance are shown and a flow diagram and specifications are included.

97 MOTOR GRADER

Allis-Chalmers Manufacturing Company—The AD-40 motor grader, largest in the company's grader line, is described in this 16-page color catalog. In addition to describing such features as "Hydraguide" steering, extra high clearance, easy working controls, and full visibility for the operator, the catalog also includes action pictures showing what the various features mean in terms of work the AD-40 can do. Power is provided by a Diesel engine with a rated 104 brake hp.

98 MOTOR GRADER

The Galion Iron Works and Mfg. Co.—Catalog No. 375, on the Model 118 motor grader is available. Time-proved features are listed and a construction detail chart, sections on the Galion constant mesh transmision and accessories and attachments are included.

99 MOTOR SWEEPER

Austin-Western Co.—An 8-page catalog, AD-2042, pictures and describes the Model 40 motor sweeper with its unique direct broom-to-hopper sweeping which makes unnecessary the conventional belt conveyor or squeegee elevator. While designed primarily for use by municipal street and park departments, the Model 40 is also well adapted to use on airports, and in and about industrial plants of many types. Included in the catalog are brief specifications and photographs of the sweeper in operation on typical jobs.

100 OUTDOOR LIGHTING

General Electric Co.—Bulletin GEA-3640D, "Outdoor Lighting for Industrial Plants" contains many helpful suggestions for properly lighting plants. Adequate lighting of roadways, loading platforms, parking areas and property lines can easily be obtained with the luminaires and floodlights described.

RETURN THE COUPON TODAY FOR IMMEDIATE RESULTS!

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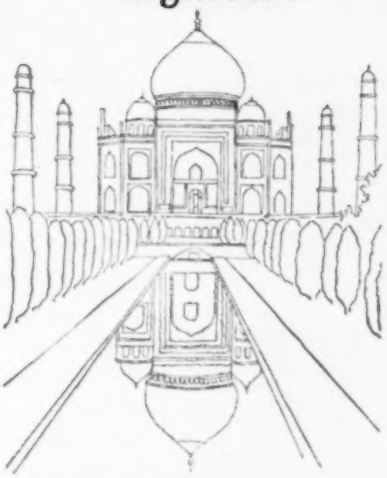

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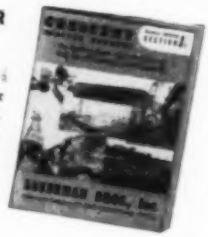
BULK STORAGE BY POWER SCRAPER . . .

tells how to stockpile and reclaim bulk materials with power scrapers—both indoors and out. Ask for Catalog E.

CRESCENT SCRAPER BUCKETS . . .

lists standard sizes ½ to 15 cu. yds.—their use with boom machines—buckets for drag scrapers. Ask for Catalog I.



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This sewer was badly disintegrated and in some places at point of collapse. All disintegration was removed wire mesh and reinforcing bars placed and "Gunite" (a mixture of cement and sand applied pneumatically) was used to complete the restoration.

This method of repair has been so successful that the City of Savannah has again contracted with us for the repair of another mile of concrete sewer.

The Cost:—A fraction of the cost of a new sewer!

Your sewer problems will receive our immediate attention.

Engineers: Our free "Gunite" Bulletin showing repairs to dams, reservoirs, bridges, and all types of industrial plants should be in your office. Send for it. Our engineers are available to help you with your "Gunite" problems. Address our nearest office:

PRESSURE CONCRETE CO.

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Contractors and Engineers

193 Emmet St., Newark 5, N. J.
33 N. LaSalle St. Chicago, Ill.
S. Court St. Florence, Ala.
Liberty Life Bldg., Charlotte N. C.

CATALOG DIGESTS

101 PACKAGE WATER CONDITIONER

The Permutit Company—Bulletin 3869 describes Permutit's Package Water Conditioning Plant, an extremely versatile and self-contained unit, designed to coagulate, clarify, filter, neutralize de-alkalize, and soften raw water supplies. Its 8 pages lists the component parts of the complete water conditioner, details the principles of operation, gives ratings, capacities and sizes and illustrates several typical installations. This bulletin should be of interest to all executives and engineers dealing with water problems.

102 PAVING TREATMENTS

American Bitumuls & Asphalt Company—A 28-page, two-color booklet describes in fully scenic photographic form and with basic tabular data the newest practice in step-by-step construction of surface treatments, armorcoats and penetration pavements with Bitumuls emulsified asphalt.

103 PENCIL SKETCHING

American Lead Pencil Co.—24 pages of helpful illustrated instructions on pencil sketching. Only 25¢ with two free Venus drawing pencils.

N. B. There is a charge for this book. Make checks payable to the American Lead Pencil Co.

104 PILES

MacArthur Concrete Pile Corporation—A 4-page folder entitled "Foundation Piling of Every Type" giving description of various types of MacArthur piles and company engineering services is available and also a semi-technical 4-page folder for pile reference "Planned Foundation Piling for Foundation Construction." Therein is presented technical reasons covering the use of various types of foundation piles.

105 PILES

Raymond Concrete Pile Company—Standard and step-tapered piles are described in literature which also includes information on the scope of Raymond's activities covering every recognized type of pile foundation—concrete, composite, precast, steel, pipe and wood piles; also caissons, underpinning. Domestic operations also include construction involving shore protection, shipbuilding facilities, harbor and river improvements, and cement-mortar lining of pipelines in place. Raymond's foreign services include every type of construction.

106 PILES AND CAISSONS

Western Foundation Corporation—An 8-page bulletin on concrete piles and caissons is offered. Services performed by Western Foundation are enumerated and seven types of cast-in-place concrete piles such as: the button bottom, concrete pedestal, compressed concrete and wood composite, are outlined in the catalog.

107 PILES

The Union Metal Mfg. Co.—has recently published Catalog No. 81 containing descriptive information, engineering and test load data on Monotube Piles. It also includes numerous photos showing a wide range of job applications throughout the country. The Monotube is a fluted, tubular steel pile, either fully tapered or combining tapered and uniform sections. It is driven directly with a standard crane, leads and hammer, without the use of driving core or mandrel. Advantages listed: light weight, easy handling, speedy driving, economical field extensibility, visual inspection after driving, high load-carrying capacity with consequent economy per ton of load carried.

108 PIPE CEMENT LINING

Centriline Corp.—A booklet describes the method of reconditioning pipe lines in place by placing a cement mortar lining on the inside surface which will stop leaks, corrosion and increases flow coefficients. This work can be done in pipe diameters from 4 in. to 144 in. with a minimum interruption of service.

109 PIPE FABRICATIONS

Naylor Pipe Company—Bulletin No. 525 covers standard and special fabrications for use with light weight pipe. All types of fabrication of standard weight pipe also provided.

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Inquiries invited.

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metal forms for concrete construction

CATALOG DIGESTS

110 PIPE LININGS

Pipe Linings, Inc.—"Tate Process," a 10-page illustrated, multicolor bulletin covers a method of lining smaller diameter water, oil, or gas pipe lines "in place." The service cleans corroded matter and tubercules from pipe walls and applies smooth cement-mortar lining.

111 PIPE & PIPE FABRICATION

L. B. Foster Company—Specifications for all sizes of pipe from $\frac{1}{8}$ in. to 24 in. in diameter are included in a catalog, titled "Pipe and Pipe Fabrication." Tables giving data and description, wall thickness, weight, etc., cover all schedule pipe from Schedule 20 through Schedule 160, also standard, extra strong and double extra heavy pipe, electric-weld tubing, welding fittings and flanges, oil well casing and water well casing. The 16-page catalog describes Foster's pipe fabrication facilities for structural uses, including portable docks, sewer inlets, fence posts, hand railings, stadium bleachers, racks, portable scaffolding, etc.

112 PIPE SPECIFICATIONS GUIDE

Naylor Pipe Company—Bulletin No. 507 covers specifications on light weight pipe, fittings, flanges and connections in sizes from 4 in. to 30 in. in diameter for applications in construction, dredging, mining, materials handling, oil, power plant, paper and sewage disposal fields.

113 PLATE FABRICATION

Contract Division, American Steel Dredge Company, Inc.—An 8-page catalog features, in color, a series of fabricated products. The catalog gives visual proof of the types of fabrication which can easily be handled with their specialized experience and equipment. In addition, samples of light weldments and complete assembly operations are also shown.

114 PNEUMATIC TIRE ROLLER

Wm. Bros Boiler & Manufacturing Co.—has a bulletin on the Roll-O-Pactor, the giant pneumatic tire roller for heavy work on dams, dikes, super highways, airfields, and other deep fills. Included are illustrations, charts, specifications and compaction data.

115 PNEUMATIC TIRE ROLLERS

Wm. Bros Boiler & Manufacturing Co.—A bulletin on "full coverage" pneumatic tire rollers is available. Bros roller models are presented and action photographs show them on all kinds of compaction jobs—all types of soils and fill depths. Both the straight-wheel design and wobble-wheel design are described and illustrated. General specifications are included.

116 POCKET TRANSIT

Wm. Ainsworth & Sons, Inc.—A booklet describing and outlining the use of the Brunton pocket transit and accessories is available. The booklet shows how horizontal and vertical angles can be determined to approximately one degree by an instrument weighing only $8\frac{1}{2}$ ozs.

117 PORTABLE ASPHALT PLANTS

Hetherington & Berner, Inc.—Bulletin P-52 on portable asphalt plants is available. The design of the PA and PE type plants featured in this bulletin is so flexible that they can be adapted to provide dependable high production performance under almost any combination of conditions. Illustrations, features, dimensions, specifications, etc., are included.

118 POWER DISTRIBUTION

General Electric Company—offers a guide to modern plant electric power distribution practices. This large bulletin designated GEA-5900 explains in detail 12 ideas on industrial power distribution that will help maintain power continuity, reduce installation and operating costs, safeguard personnel and equipment, and plan a complete packaged distribution system. Each idea is developed by graphs, electrical diagrams, or photographs of equipment and installations.

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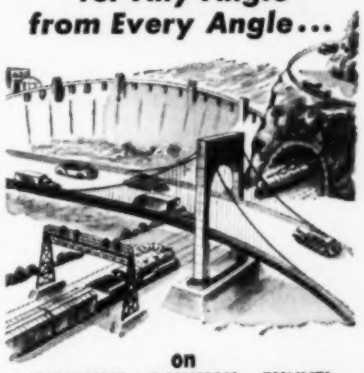

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Light-weight, sturdy Tilting Level for universal application.

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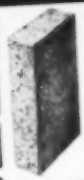

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Forms an easily compressible cushion. Highly waterproof, low in cost. Made in 5 thicknesses in any length or width. Formed between two sheets of asphalt saturated felt paper which increases strength and rigidity, improves handling.

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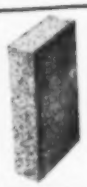
Blends with color of concrete. For use in architectural concrete structures such as bridges, viaducts, etc., where black color of ordinary fillers would be objectionable. Fully resilient —non-extruding.



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High recovery factor (95%) after compression, non-extruding qualities and light color make Cork Joint Filler ideal for use in flood walls, outlet works and spillways, sewage treatment plants, filtration plants and bridge construction.

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TWA twin hangars, Chicago, each 270 feet long, with clear span of 270 feet and center height of 65 feet. Five arch ribs were poured monolithically with shell over prefabricated falsework furnished by Timber Structures, Inc. Each hangar was completed in two sections, with falsework being lowered and moved intact into position for pouring the next section. Hangar was designed by Ammann & Whitney, engineers; W. E. O'Neil Construction Co., Chicago, was general contractor.

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This roof arch form is Timber Structures' answer to the need for sturdy, precision built falsework that is thoroughly engineered, quickly assembled and easily moved for repetitive use. It required only two hours to move the assembly into position for the second pour, and only half a day to move it intact into the adjoining hangar. ...Let us show you how similar falsework will speed your work and increase profits on your next job. See your nearest Timber Structures office, or write for information.

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CATALOG DIGESTS

119 POWER GRADERS

Austin-Western Co.—A 24-page catalog, AD-2112, pictures and describes the "88-H," the "99-H" and the Master "99" power graders with exclusive all-wheel drive and all-wheel steer. All types of work—rough grading, heavy ditching, scarifying, snow plowing, terracing and drainage, mixing, loading, rolling and bulldozing—are illustrated and discussed. Included also are brief specifications, a description of exclusive design features and detailed illustrations of the attachments.

120 PRECISION INSTRUMENTS

Berger Scientific Supplies, Inc.—39 precision drawing sets, triangles, protractor, T-squares, curves, slide rules and scales are illustrated and described in a brochure. The Berger drafting kit, which combines all necessary draftsman's instruments and supplies in one easy-to-carry case, is also illustrated.

121 PRECISION INSTRUMENTS

C. L. Berger & Sons, Inc.—Complete specifications on the Berger "N" line of moderate-priced builders' instruments are included in an illustrated brochure now available. Companion line to the company's engineering, mining and astronomical instruments, the "N" line consists of a convertible transit-level, a 12-in. heavy-duty dumpy level, a service transit level (farm level) and a hand level.

122 PRECISION INSTRUMENTS

C. L. Berger & Sons, Inc.—An informative, 4-page brochure, combining a catalog and calculating chart, has been prepared. Pictured in four colors on the cover is the Berger Type R transit, one of the many instruments produced by the 81-year-old firm. On the center spread are photographs and code names for 12 types of Berger instruments, from an 18-in. dumpy level to a plane table alidade.

123 PRESSURE-CREOSOTED PILES

Koppers Co.—A 16-page booklet designed to assist engineers in the evaluation of pressure-creosoted foundation piles for various types of construction projects has been issued. The booklet cites important national, regional, and city construction codes which allow pressure-creosoted wood foundation piles for permanent construction. Typical examples of the use of these piles are described and pictured.

124 PUMPS

A. O. Smith Corp.—The company offers three bulletins describing pumps of various capacities ranging from 50 to 5,000 gpm. These bulletins are completely illustrated and include details of the component parts as well as the design and construction features which add to the long life and operating economy of the pumps. Features include the especially-designed Smith-built motors and the fabricated all-steel head of the pumps.

125 RACK RAKE

Newport News Shipbuilding and Dry Dock Co.—A 32-page, two color booklet has information regarding the Newport News mechanical rack rake used to clean trash racks at water intakes for hydroelectric plants, steam plants, pumping stations, canals, and similar installations. Booklet includes a number of typical installation arrangements for a variety of developments.

126 ROAD MACHINERY

Wm. Bros Boiler & Mfg. Company—A picture folder describing the Bros line of road machinery is available. The folder illustrates and describes Bros pneumatic tire rollers and giant 50-ton "Roll-O-Pactors," drum-type tampers. Bitumizer distributors, Spraymatic spray bars, portable steam generators and asphalt circulators are also shown.

127 RUBBER ROADS

Natural Rubber Bureau—A 52-page booklet entitled, "Stretching Highway Dollars With Rubber Roads," is offered. This booklet gives the whole story on the history of rubber roads, and describes in detail the test roads using natural rubber powder that have been laid in the United States and Canada through the 1951 paving season.

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A genius centuries ahead of his time, the inventor of the roller built a tremendous milestone on the highway of progress. Crude and haphazard . . . the first roller immeasurably lightened the work of primitive man and began the history of engineering.

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The vertical axis of the Kern DKM2 is mounted on 20 precisioned ball bearings. This exclusive Kern system permits the instrument to maintain its position within 1 second . . . allowing almost absolute accuracy under any conditions. Perfect within ¼ micron . . . the balls move on an optically ground surface . . . bringing you unquestioned precision without fear of accidental slipping. Another demonstration of Kern performance; the DKM2 is only one of a complete line of Kern Surveying Instruments.

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Kern Surveying Instrument Division

PAUL REINHART CO., INC.

66 Beaver Street, New York City

CATALOG DIGESTS

128 SANITARY LANDFILL

Allis-Chalmers Manufacturing Company—"Sanitary Landfill an Important Community Benefit" is a 12-page color catalog discussing in detail methods of garbage, rubbish and refuse disposal. Pictures illustrate various methods of landfill, including area trench and ramp methods.

129 SCRAPERS

Caterpillar Tractor Co.—Scrapers and their application to earthmoving and bulk material handling is the subject of an 8-page booklet, "A Good Business Deal." Written in the form of an open letter to the earthmoving businessman, the booklet explains the advantages of scrapers over other earthmovers. Tractor-scraper combinations are shown in sanitary landfill operations, repairing levees, relocating highways, dredging coal and leveling plant sites. Four points—quality, service, performance, price—of Caterpillar built scrapers fill the sales theme of the release.

130 SEWAGE REGULATORS

Brown & Brown, Inc.—Bulletin 81 with supplements A and B describes sewage regulators designed to automatically control diverted sanitary flows from combined sewer systems, either by cutting off such flows entirely during storm periods, or by governing such diversions to a constant predetermined quantity regardless of storm conditions. Charts for the ready solution of diversion problems are included.

131 SHOT CORE DRILLS

Acker Drill Company, Inc.—offers a bulletin describing the Model KR shot core drill. The KR drill is especially suited for obtaining highway and airport runway test cores from concrete, bituminous or masonry surfaces. The entire unit is light enough for mounting on a pick-up truck or trailer. Power unit can be gasoline, kerosene, diesel or electric motor.

132 SHOVELS

Caterpillar Tractor Co.—Versatility of a new product is emphasized in "Shovels at Work." The No. 6 shovel with the earlier released HT4 shovel are pictured in a variety of earthmoving and industrial operations. That these units are not merely tractors with hydraulic shovels attached, is brought out. They are engineered and built as an integral unit—a scientifically balanced machine. Buyers find them useful for moving earth and coal, cleaning slag from open hearth furnaces, backfilling foundations, loading lumber and filling trucks and gondola cars.

133 SOIL SAMPLING TOOLS

Acker Drill Company, Inc.—offers a 16-page bulletin describing their complete line of soil sampling tools. The science of soil mechanics and the special tools required for accurate sub-surface exploration in various soil conditions, is thoroughly discussed.

134 STAINLESS STEEL TANKS

Rodney Hunt Machine Co.—A bulletin is available showing the range of Rodney Hunt engineered stainless steel fabrications. Particular attention is given to stainless steel tanks of standard and special construction in a wide range of sizes. A simplified quotation request sheet with detailed standard specifications is included. With a large, modern shop exclusively for this stainless steel work, Rodney Hunt is able to handle stainless steel fabrication from small vessels to complex equipment for textile, paper, chemical and other industries.

135 STEEL DREDGES

American Steel Dredge Company, Inc.—A 16-page catlog illustrating in color its full line of hydraulic dredges is available. A series of field photographs shows the 15, 12, 10 and 8 in. sizes hydraulic dredges in operation. In addition, many of the modern design and construction details are illustrated. A table of typical dredge data is included for handy reference of dredge specifications.

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Model 1039

Searching always to achieve greater accuracy... easier, more comfortable operation . . . Kern designers have added a small ball to the end of a drawing pen . . . and discovered a miraculous balance . . . a floating action that leaves you loose and relaxed at the end of the longest day! True, only a tiny detail . . . but typical of the famous Kern tradition . . . a craftsmanship that strives constantly to bring you the finest instrument possible from every single aspect!

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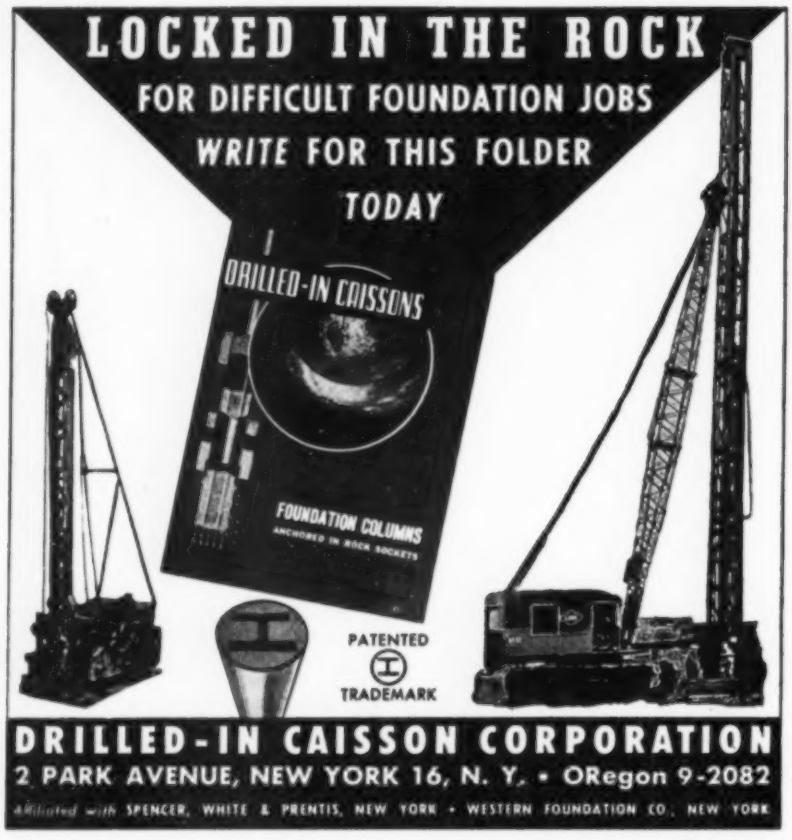
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CATALOG DIGESTS

136 STEEL FORMS

Economy Forms Corp.—A booklet on steel forms for concrete construction is offered. It has numerous pictures showing the simple handling, applications, and use of the forms for all types of heavy construction; tunnels, culverts, sewage & water treatment plants. Special forms designed to solve concrete construction problems are also shown.

137 STEEL RESERVOIRS

Chicago Bridge & Iron Company—A 24-page bulletin entitled "Horton Steel Reservoirs and Standpipes," illustrates installations from 50,000 gals to 10,000,000 gals. Standard installations shown with cone, umbrella and ellipsoidal roofs and special designs with ornamental cornices and colonnades. Information included on foundations, pickling and painting and fire protection.

138 STEEL RIGID FRAMES

Martin P. Korn—A manual of design and construction, 181 pages, 8½ by 11, profusely illustrated, is now available. Its author, Martin P. Korn is a noted lecturer, authority and pioneer in rigid frame design and construction. Distinguished contributors and tables for instant design make this manual the only book of its kind. It has been widely acclaimed by eminent authorities. Book is priced at $4.50.

N. B. There is a charge for this book. Make checks payable to J. W. Edwards, Publisher, Inc.

139 STEEL SHEET PILING

L. B. Foster Company—Contractors faced with the problem of selecting proper piling for construction projects will find their task simplified because of a catalog titled, "Steel Sheet Piling." In addition to giving comparative information on steel sheet piling manufactured by major steel companies, the catalog also cites the advantages of renting piling. To help the contractor in estimating a job, one section lists the number of piles required for various wall lengths. Included also in the 20-page catalog are piling data related to circular and diaphragm-type cellular cofferdams, circular cofferdams, Z-piling and other connections, corner pieces, and specifications for piling sections. Pile extractors and pile hammers also are discussed.

140 SURVEYING INSTRUMENTS

C. L. Berger & Sons, Inc.—A 16-page condensed catalog, "Accuracy in Action," illustrates the engineering and surveying instruments manufactured by the company. General characteristics, optical systems and accessories for the Berger line of engineers' transits, levels, mining transits, theodolites, collimators and alidades are fully described with essential specifications for each. A section devoted to builders' and contractors' instruments is also included.

141 SURVEYING INSTRUMENTS

Fennel Instrument Corporation of America—offers a folder on their line of precision instruments. Photographs, detailed descriptions of the models, prices, etc., are included.

142 SURVEYING INSTRUMENTS

Paul Reinhart Co., Inc., Kern Surveying Instrument Division—A 32-page brochure offers a brief description of the most important instruments manufactured by world-famed Kern & Co., Ltd., of Aarau, Switzerland. Fully illustrated, it acts as an index to the detailed literature available on each instrument. Included in the brochure are double-circle theodolites, self-reducing tachometers, plane table equipment, pentagonal prisms and many other exceptionally fine instruments.

143 SURVEYING INSTRUMENTS

The Union Mercantile Company—has literature available on the following surveying and engineering instruments: 18 in. dumpy level; 5 in. engineer's transit; and 11 in. builder's level. This literature describes the finest of Japanese optics built to standard American specifications. Prices are far below comparable values. These instruments are equal to the world's finest. Complete technical descriptions, photographs and price list are included.

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★ WORK unhampered by water
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Complete with collapsible tripod and carrying case
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Write for free folders on other surveying and engineering instruments

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465 Calif. St. • San Francisco, Calif.

CATALOG DIGESTS

144 SURVEYING INSTRUMENTS

Warren Knight Co.—The 56 page, 10th Edition of the company's catalog of precision transits, levels, clinometers, protractors, etc., and a general line of engineering equipment and supplies is now available for distribution to engineers without charge or obligation.

145 SURVEYING INSTRUMENTS

David White Company—offers Bulletin 1052 on surveying instruments for all purposes. The present edition tells the story of the most recent changes and developments in the field of surveying instruments and engineer's field supplies. The catalog presents an exceptionally large assortment of high-grade and up-to-the-minute products.

146 SURVEYING INSTRUMENTS

David White Company—has a series of questions and answers on surveying instruments. It was originally intended for their dealers, but since published it has caused such a wide interest among universities and highway departments that it is offered to anyone who is interested.

147 SURVEYING INSTRUMENTS

Henry Wild Surveying Instruments Supply Co. of America, Inc.—Optical squares, the size of a plumb-bob, never fail to intrigue persons unfamiliar with their usage. By means of Pentagonal Prisms these squares turn a true right angle. They are the smallest and most inexpensive "Transit" for laying out and checking buildings, concrete forms, and boundries as well as cross sections and Topo maps. A well illustrated booklet explaining the working principle and the many fields of application of both the single and double prisms has just come off the press.

148 SWIMMING POOLS

Pressure Concrete Company—A swimming pool brochure, which illustrates pools the company has constructed as well as information toward the planning of new pools is available. There is also a section dealing with repair and restoration to existing pools.

149 TANDEM ROLLERS

Buffalo-Springfield Roller Co.—A 12-page booklet describing the company's new line of C Model tandem rollers is available upon request. The pamphlet describes the following features of tandems from 5 to 16 tons: open grillwork over both sides of the drive roll which allows operator to see the roll edge directly through top of machine; increased ground clearance to 17 in. on 5-9 ton tandems, 20 in. on 8-15 ton tandems; bevel gear final drive armored by massive steel freight frame member; and heavy duty tapered roller bearings on both axles. These and many other features as well as pertinent specifications are covered.

150 TANDEM ROLLERS

Gallion Iron Works & Mfg. Co.—Catalog No. 325 on variable weight tandem rollers is offered. The many improvements in construction and operation are fully described and illustrated. Complete specifications are also listed.

151 TECHNICAL BOOKS

John Wiley & Sons, Inc.—Information on authoritative, up-to-date technical books in all branches of civil engineering is available in a special Wiley catalog. Of particular interest to civil engineers are the descriptions of standard reference and textbooks on structural engineering, foundations, hydraulic and hydroelectric engineering, municipal engineering, architecture, irrigation, highway and bridge engineering, building construction, and many other related subjects.

152 TECHNICAL DATA CATALOG

Lefax—Listing over 2000 subjects, the Lefax catalog of pocket size technical data books is off the press. These handy reference books cover every branch of engineering, are clear cut, comprehensive, authoritative, for use by engineers, technical workers, executives, etc. Continuously revised, each book contains approximately 140 pages of pertinent data including current advances. Subjects include: hydraulics, machine design, piping data, surveying tables, reinforced concrete, highway engineering, electricity AC-DC, AC motors and generators, and others.

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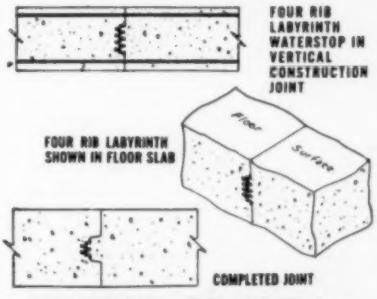

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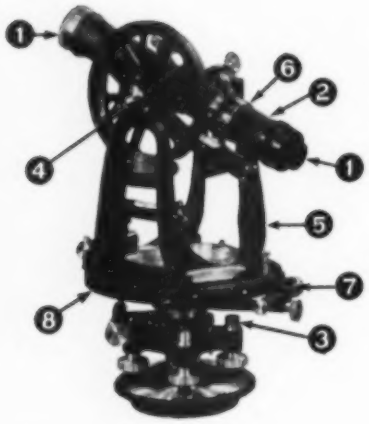

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CATALOG DIGESTS

153 THEODOLITE

Geo-Optic Company, Inc.—has a leaflet describing the optical universal theodolite T50 with terrestric telescope (erecting eyepiece). The T50 enables surveyors to cope with any possible problem of triangulation and to obtain results of the highest accuracy. All readings are done from one position—an important time factor. Other advantages and data are included.

154 THREE-WHEEL ROLLERS

The Galion Iron Works & Mfg. Co.—An attractive four-color catalog No. 294, describes the company's three wheel rollers. Complete specifications are given together with detailed description and photos of the many construction and operation features.

155 TIDE GATES

Brown & Brown, Inc.—Bulletins 69 through 73, 75 and 76 describe various types of tidal gates, both circular and rectangular, and give authentic information regarding head losses.

156 TILT-UP CONSTRUCTION

Portland Cement Association—A 32-page illustrated booklet discusses a method of construction in which wall panels are cast in the horizontal position, usually on the floor of the building and then tilted into a vertical position and tied together to form a wall. It covers the advantages, design, construction details, methods of tilting and insulation of walls.

157 TIMBER BRIDGES

Timber Structures, Inc.—offers an 8-page catalog of timber bridges featuring glued laminated timbers used with modern engineered connections. Standard bridge types include deck arch, girder, deck truss, bowstring truss, trestle and composite deck. Application of arch centering and prefabricated falsework also is included. Illustrations include photographs and schematic drawings of various bridges.

158 TIMBER CONSTRUCTION

Timber Structures, Inc.—New color booklet, "Modern Construction with Engineered Timbers" shows the use of timber members as a modern engineering material. Technical data includes sizes and properties of glued laminated beams and purlins; standard thicknesses of laminations and limiting curvatures; arch dimensions; dimensions, sizes and weights of bowstring and parallel chord trusses.

159 TONGUE AND GROOVE JOINTS

Servicised Products Corporation—A tongue and groove joint one page circular describes tongue and groove joint produced by Servicised Products for forming keyed construction joints.

160 TRACING PENCIL TEST KIT

American Lead Pencil Co.—The kit contains samples of Venus tracing pencils for testing on various types of tracing papers. This new pencil contains an active chemical to produce clearer, sharper white or blueprints when reproduction is made from a pencil drawing.

161 TRACTORS

International Harvester Company—Protect your profits by high speed earthmoving by using the right sized tractor for your job. Select your power from the most complete line of International Harvester crawler tractors from 32 to 148 drawbar horsepower. Latest catalogs are available in whatever power range requirement you specify.

162 TUNNEL & MINE EQUIPMENT

Mayo Tunnel & Mine Equipment—has available, Bulletin #18a, which illustrates haulage equipment for tunnels and mines. This bulletin shows compressed air locomotives, diesel locomotives, mine cars and car passers.

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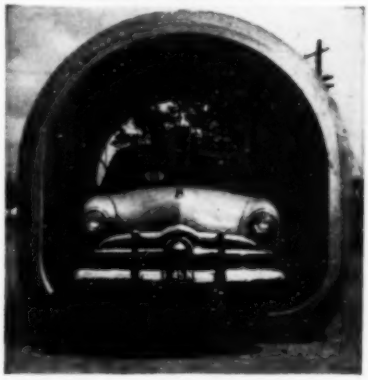

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The customary notice of technical papers available, including order coupons, has been omitted from this issue. A complete list of papers available under the new procedures will appear in the November issue. As of September 30, 1953 (November 1, to members abroad) the allotment of 40 free copies of Proceedings-Separates will be discontinued. Beginning with the October Separates, every registered member of a given Division will receive, free and automatically, all papers sponsored by that Division.

After the automatic mailing, the papers will be listed in "Civil Engineering" as before, so that you may order, by coupon, any paper of interest not sponsored by your Division. Single copy rates for such papers will be 25 cents to members (50 cents to non-members). Also, you may subscribe for all papers sponsored by any other Division at a subscription rate of $2.00 per year per Division, or $12.00 per year for all papers from all Divisions.

The listing of current papers under the new distribution procedures will begin with the November issue of "Civil Engineering." The October Separates are those scheduled for presentation at the Annual Meeting in New York, N.Y., during the week of October 18.

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CATALOG DIGESTS

163 VERTICAL BOOM DITCHER

Barber-Greene Company—The Model 44-C vertical boom ditcher is designed for use by contractors, governmental bodies and utilities companies. The ditcher has digging widths of 12 and 18 in. and can dig to a depth of 8 ft 3 in. It is full crawler mounted and equipped with an automatic clean-out bucket, automatic overload release sprocket and the exclusive Barber-Greene vertical boom and many other design refinements. The digging buckets are equipped with the new patented curve tooth design. This 8-page, two color booklet illustrates many typical applications of the 44-C ditcher.

164 VIBRATORS

Viber Company—New applications and equipment development on interchangeable vibrator units, flexible drive, full depth internal concrete paving, rubber-tipped, plus PX Models and the new Viberlec, both external vibrators, are described in a recently published catalog. Specifications concerning speeds, weights, sizes, types of power, etc., are included.

165 WALL FORM CONSTRUCTION

Symons Clamp & Mfg. Co.—has available for immediate distribution a new 44-page catalog on a system of wall-form construction. It has all of the latest information and improvements in the Symons Forming System. Illustrations show in detail how simply and easily the forming system operates. Actual construction where Symons forms have been used are well illustrated—showing the forms in use as well as completed jobs. Also blueprint illustrations and complete specifications are given—material and equipment necessary, time required and cost figures on actual jobs.

166 WATER CONDITIONING DATA BOOK

The Permutit Company—Pocket size Data Book No. 2478A was compiled for the convenience of practicing engineers and those who work with water conditioning problems. It covers such subjects as hydraulics, impurities in water, chemicals used in water treatment, specific gravities and chemical reactions. The 108 pages of invaluable data, with 78 tables of information is bound in a leatherette cover and gold stamped.

167 WATER DAMAGE CONTROL

Western Waterproofing Company—An 8-page brochure which offers a comprehensive review of modern waterproofing methods, is available. It is a professional and practical treatise on a vital engineering problem.

168 WATER FILTERS

Proportioneers, Inc.—Bulletin 1800 describes Pur-O-Cel Diatomite filters for use in filtration of water in municipal and industrial water works and in swim pool recirculation systems. Engineering data on the application of these filters, including specifications and dimensions covering the complete recirculation and purification systems, are given.

169 WATER LINE REQUIREMENTS

Price Brothers Co.—has "Check Sheet of Water Line Requirements," a four-page bulletin that can be extremely helpful to consultants and to water works management and engineers. Lists and subdivides major requirements, as life expectancy, strength, gallons of water delivered, maintenance and cost. A comparison check form is provided on which you can evaluate the benefits of each type of pipe line material you may want to consider.

170 WATER POWER EQUIPMENT

Newport News Shipbuilding and Dry Dock Co.—A 75-page, two-color booklet pictures 40 hydraulic power developments and some of the equipment furnished by the company. Details of the developments and other engineering information regarding their building and operation is included.

TIDE GATES

Fig. B-144-A

One of Two 48" Type M Gates installed in Ft. Stanton Park Reservoir, Washington, D. C., to maintain direction of flow. See Feb. 22, 1944, issue Engineering News Record for story about this project.

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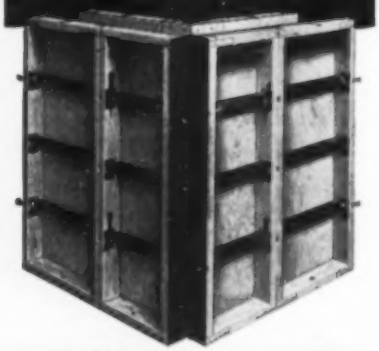

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CATALOG DIGESTS

171 WATER PURIFICATION EQUIPMENT

Infilco Inc.—Bulletin 1825-B describes the principle and applications of the Accelerator for treatment of wastes by chemical means in a single, compact unit which combines mixing, coagulation and clarification.

172 WATERSTOPS-LABYRINTH TYPE

Water Seals, Inc.—A bulletin describes the Harza labyrinth waterstop. The catalogi ncludes description and drawings of typical applications for the new type waterstop, which features exceptional water tightness and ease of installation in the concrete forms.

173 WATER WELLS, PUMPS, SERVICES

Layne & Bowler, Inc.—gives a brief description of its comprehensive water supply equipment and services for municipalities, industries and farms in a new illustrated folder. Subjects include water well drilling, special drilling, vertical turbine pumps, irrigation pumps, specially designed pumps, shutter screens for gravel wall wells, water well acidizing and other service work. The folder describes additional helpful literature available on each of these subjects.

174 WELLPOINT DEWATERING

Complete Machinery & Equipment Company—has prepared a new catalog for the benefit of those interested in a better understanding of water removal from construction sites. The catalog titled, "Dewatering with Complete Wellpoint Systems," shows the reason for wellpoint dewatering over other methods. It also illustrates the proper layout of a wellpoint system for dewatering various types of excavations, describes the installation, operation and maintenance of a wellpoint system, and finally proves by actual photographs what results can be secured by means of wellpoint dewatering.

175 WELLPOINT DEWATERING SYSTEM

John W. Stang Corp.—A catalog describes the component parts of the Stang wellpoint dewatering system; its planning, engineering and various methods of installation. Specific installations on dams, power houses, pipelines, tunnels, etc., are illustrated from photographs made in the field. Heavy construction of all types in all varieties of soil conditions where ground water is encountered is described fully.

176 WELLPOINTS

Moretrench Corporation—has a reprint of an article, "Wellpoints Can Do Many Jobs" written by Mr. Byron J. Prugh. It is a precision wellpoints and what they can do. Photographs and diagrams are included.

177 WELLPOINT SYSTEMS

Foundation Equipment Corporation—offers literature on wellpoints, wellpoint pumps, and dust control systems. The brochures describe the Pre-Bid Engineering Service that is available without obligation.

178 WIRE ROPE AND SLINGS

L. B. Foster Company—Tables which give technical data on the approximate strength and weight of various types of wire rope, in all sizes from one-quarter inch in diameter to 2½ in. in diameter, are featured in a bulletin titled, "Wire Rope and Slings." The 4-page bulletin also has illustrations of slings, blocks, clips, hooks, sockets, shackles, turnbuckles, thimbles, swivels, links and eye bolts and nuts.

179 ZEOLITE WATER SOFTENERS

The Permutit Company—Bulletin 2386 describes in its 16 pages the multiple economies effected by curing troubles caused by the utilization of hard water. The bulletin lists several industries in which steam and water are of importance. It explains the three basic types of ion exchange equipment and shows how these units can be profitably utilized.

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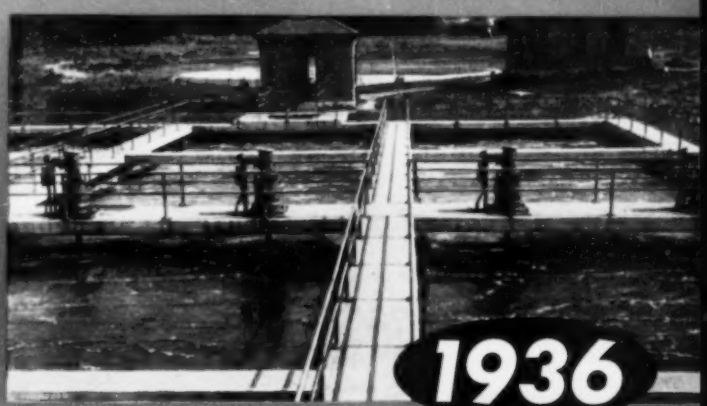

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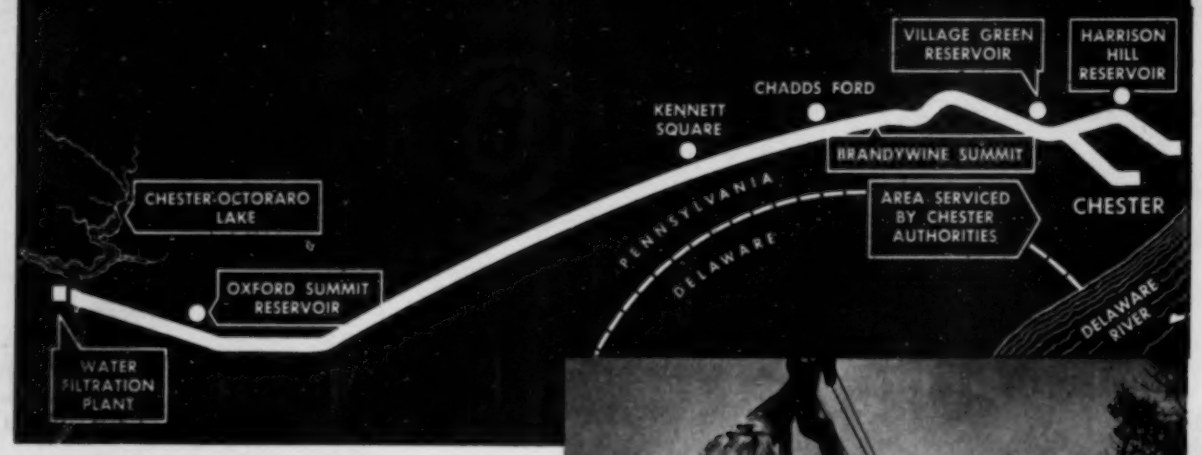

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